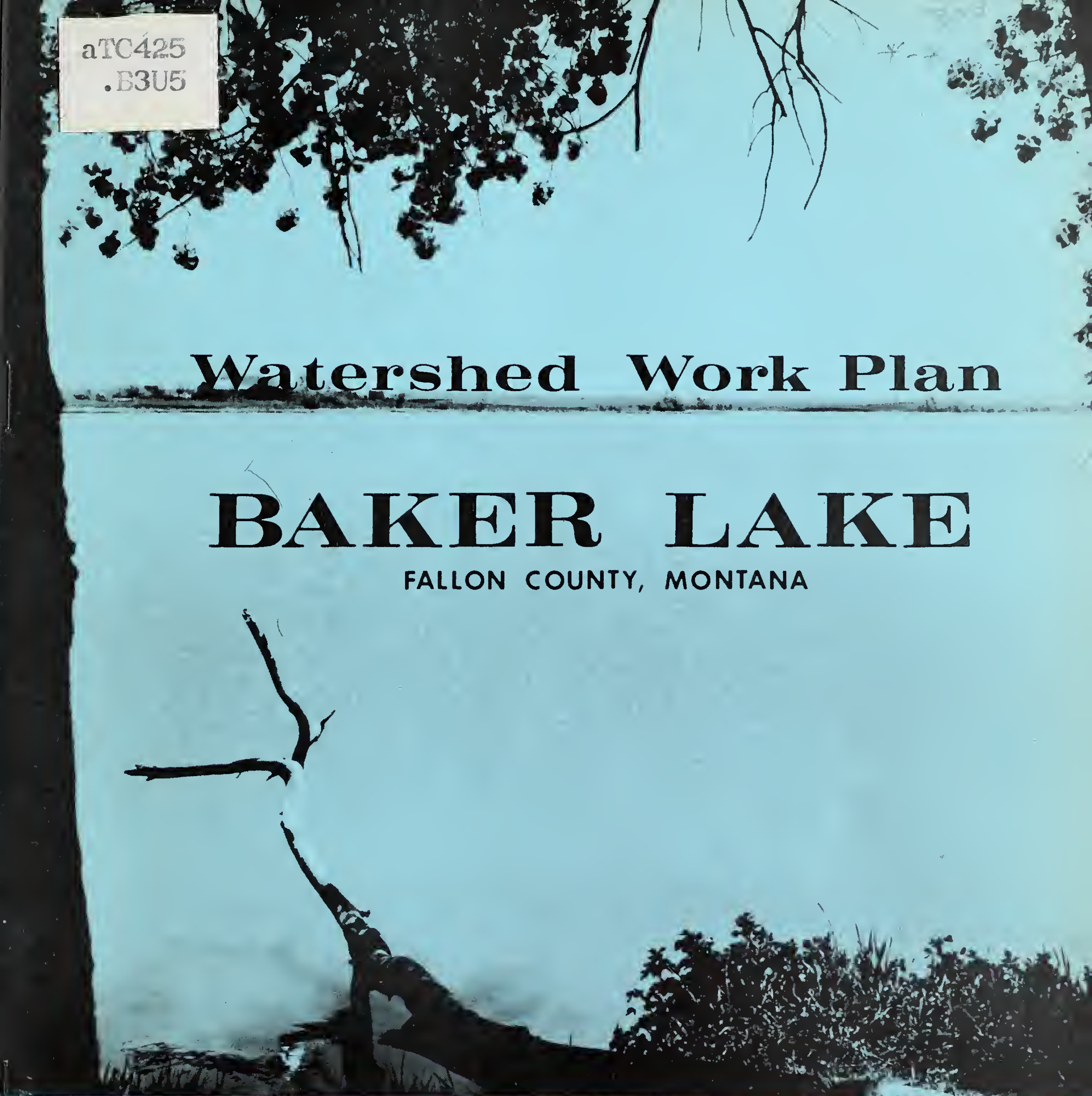

Watershed Work Plan

BAKER LAKE

FALLON COUNTY, MONTANA

U.S. DEPARTMENT OF AGRICULTURE - SOIL CONSERVATION SERVICE

AUGUST 1972

Prepared under the authority of the Watershed Protection and Flood Prevention Act

(Public Law 566, 83rd Congress, 68 Stat. 666) as amended.

USDA-SCS-PORTLAND OREGON 1972

WATERSHED WORK PLAN

BAKER LAKE WATERSHED

Fallon County, Montana

Prepared Under the Authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83d Congress, 68 Stat. 666), as amended.

Developed by:

City of Baker
Fallon County
Little Beaver Conservation District

Technical assistance for developing and writing this plan provided by:

U. S. Department of Agriculture, Soil Conservation Service
Bozeman, Montana

and

U. S. Department of the Interior, Bureau of Sport Fisheries and Wildlife;
State of Montana, Department of Fish and Game

August 1972

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WATERSHED WORK PLAN AGREEMENT

Between the

CITY OF BAKER

FALLON COUNTY

LITTLE BEAVER CONSERVATION DISTRICT

(hereinafter referred to as the Sponsoring Local Organization)

State of Montana

and the

Soil Conservation Service
United States Department of Agriculture
(hereinafter referred to as the Service)

Whereas, application has heretofore been made to the Secretary of Agriculture by the Sponsoring Local Organization for assistance in preparing a plan for works of improvement for the Baker Lake Watershed, State of Montana, under the authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83rd Congress; 68 Stat. 666), as amended; and

Whereas, the responsibility for administration of the Watershed Protection and Flood Prevention Act, as amended, has been assigned by the Secretary of Agriculture to the Service; and

Whereas, there has been developed through the cooperative efforts of the Sponsoring Local Organization and the Service a mutually satisfactory plan for works of improvement for the Baker Lake Watershed, State of Montana, hereinafter referred to as the watershed work plan, which plan is annexed to and made a part of this agreement;

Now, therefore, in view of the foregoing considerations, the Sponsoring Local Organization and the Secretary of Agriculture through the Service hereby agree on the watershed work plan and further agree that the works of improvement as set forth in said plan can be installed in about five years.

It is mutually agreed that in installing and operating and maintaining the works of improvement substantially in accordance with the terms, conditions, and stipulations provided for in the watershed work plan:

1. Except as hereinafter provided, the Sponsoring Local Organization will acquire without cost to the Federal Government such land rights as will be needed in connection with the works of improvement. (Estimated cost: $36,430) The percentages of this cost to be borne by the Sponsoring Local Organization and the Service are as follows:

Works of Improvement	Sponsoring Local Org. (Percent)	Service (Percent)	Estimated Land Rights Cost (Dollars)
Floodwater Retarding Structure			
a. Land costs for about 185 acres	100.0	0.0	9,250
b. Legal fees, survey costs, and flowage easements	100.0	0.0	1,680
c. Oil and gas field protection and alteration costs	100.0	0.0	25,500

2. The Sponsoring Local Organization will provide relocation advisory assistance services and make the relocation payments to displaced persons as required by the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (Public Law 91-646, 84 Stat. 1894), effective as of January 2, 1971, and the Regulations issued by the Secretary of Agriculture pursuant thereto. Prior to July 1, 1972, the Sponsoring Local Organization will comply with the real property acquisition policies contained in said Act and Regulations to the extent that they are legally able to do so in accordance with their State law. After July 1, 1972, the real property acquisition policies contained in said Act shall be followed in all cases.

   The Service will bear 100 percent of the first $25,000 of relocation payment costs for any person, business, or farm operation displaced prior to July 1, 1972. Any such costs for a single dislocation in excess of $25,000 and all costs for relocation payments for persons displaced after July 1, 1972, will be shared by the Sponsoring Local Organization and the Service as follows:

	Sponsoring Local Organization (Percent)	Service (Percent)	Estimated Relocation Payment Costs* (dollars)
Relocation Payments	16.3	83.7	0

*Investigation has disclosed that under present conditions the project measures will not result in the displacement of any person, business, or farm operation. However, if relocations become necessary, relocation payments will be cost-shared in accordance with the percentages shown.

3. The Sponsoring Local Organization will acquire or provide assurance that landowners or water users have acquired such water rights pursuant to State law as may be needed in the installation and operation of the works of improvement.

4. The percentage of construction costs ($191,500) of structural measures to be paid by the Sponsoring Local Organization and by the Service are as follows:

Works of Improvement	Sponsoring Local Org.	Service (Percent)	Estimated Construction Cost (Dollars)
Floodwater Retarding Structure	0.0	100.0	191,500

5. The percentages of the engineering costs ($22,980) to be borne by the Sponsoring Local Organization and the Service are as follows:

Works of Improvement	Sponsoring Local Org. (Percent)	Service (Percent)	Estimated Engineering Costs (Dollars)
Floodwater Retarding Structure	0.0	100.0	22,980

6. The Sponsoring Local Organization and the Service will each bear their costs for project administration estimated at $600 and $33,870, respectively.

7. The Sponsoring Local Organization will obtain agreements from owners of not less than 50 percent of the land above each reservoir and floodwater retarding structure that they will carry out conservation farm or ranch plans on their land.

8. The Sponsoring Local Organization will provide assistance to landowners and operators to assure the installation of the land treatment measures shown in the watershed work plan.

9. The Sponsoring Local Organization will encourage landowners and operators to operate and maintain the land treatment measures for the protection and improvement of the watershed.

10. The Sponsoring Local Organization will be responsible for the operation and maintenance of the structural works of improvement by actually performing the work or arranging for such work in accordance with agreements to be entered into prior to issuing invitations to bid for construction work.

11. The costs shown in this agreement represent preliminary estimates. In finally determining the costs to be borne by the parties hereto, the actual costs incurred in the installation of works of improvement will be used.

12. This agreement is not a fund obligation document. Financial and other assistance to be furnished by the Service and the Sponsoring Local Organization in carrying out the watershed work plan is contingent upon the appropriation and acquisition of funds for this purpose.

    A separate agreement will be entered into between the Service and the Sponsoring Local Organization before either party initiates work involving funds of the other party. Such agreement will set forth in detail the financial and working arrangements and other conditions that are applicable to the specific works of improvement.

13. The watershed work plan may be amended or revised, and this agreement may be modified or terminated, only by mutual agreement of the parties hereto.

14. No member of or delegate to Congress, or resident commissioner, shall be admitted to any share or part of this agreement, or to any benefit that may arise therefrom; but this provision shall not be construed to extend to this agreement if made with a corporation for its general benefit.

15. The program conducted will be in compliance with all requirements respecting nondiscrimination as contained in the Civil Rights Act of 1964 and the regulations of the Secretary of Agriculture (7 C.F.R. 15.1-15.12), which provide that no person in the United States shall, on the ground of race, color, or national origin, be excluded from participation, be denied the benefits of, or be subjected to discrimination under any activity receiving Federal financial assistance.

By____

Title____

Date____

The signing of this agreement was authorized by a resolution of the governing body of the City of Baker, adopted at a meeting held on ____________________

____

City Clerk, City of Baker

Date____

FALLON COUNTY

By____

Title____

Date____

The signing of this agreement was authorized by a resolution of the governing body of Fallon County, adopted at a meeting held on ____________________

____

Fallon County Clerk & Recorder

LITTLE BEAVER CONSERVATION DISTRICT

By ____

Title ____

Date ____

The signing of this agreement was authorized by a resolution of the governing body of the Little Beaver Conservation District, adopted at a meeting held on

____

____

Secretary, Little Beaver Conservation District

Date ____

Appropriate and careful consideration has been given to the environmental statement prepared for this watershed and to the environmental aspects thereof.

SOIL CONSERVATION SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE

By ____

State Conservationist

Date ____

SUMMARY

BAKER LAKE WATERSHED WORK PLAN

Fallon County, Montana

This watershed plan was developed and sponsored by the City of Baker, Fallon County, and Little Beaver Conservation District under the authority of the Watershed Protection and Flood Prevention Act of 1954 (Public Law 566). Technical assistance for developing and writing this plan was provided by U. S. Department of Agriculture, Soil Conservation Service, in cooperation with other federal and state agencies.

The Baker Lake Watershed is located in the southeastern part of Montana in Fallon County. The watershed contains 4,128 acres (6.45 square miles) and includes most of the City of Baker. Baker, which has a population of 2,584, and has made steady growth over the past 20 years, is the county seat of Fallon County and serves a multi-county area. Plains type ranching and oil and gas production are the principal industries of the county.

Watershed Problems

The principal watershed problem is flooding. Large amounts of sediment are transported from the upper watershed. Floodwater and sediment damages occur to Baker Lake and adjoining property and to urban property along the watercourse below the lake. Flooding occurs most often during the spring and summer as the result of intense rainstorms. Sediment production is high due to the general sparse cover conditions that prevail due to soil and climatic conditions.

Flooding occurs to homes, basements, streets, city parks, wells, highways, businesses, and Baker Lake. Sewer backups are common. Sediment deposition in Baker Lake, which was built in 1908, has reduced the lake capacity from 756 acre-feet to about 250 acre-feet. Baker Lake, which is the only water facility large enough for public recreation within 80 miles of Baker, has deteriorated to a point where it borders on being a detriment to the community and lakeshore property owners.

Project Objectives

The basic objective of the sponsors of this project is to reduce floodwater and sediment damages. Protection from the largest storm expected once in 100 years from the watershed above Baker Lake is desired. A secondary objective is to provide an opportunity for the reclamation of Baker Lake and further development of needed water-based recreation to be carried out separately from this watershed project.

Measures to be Installed

Land treatment measures to be installed on rangeland and dry cropland include proper grazing use, deferred grazing, ponds, pipelines, tanks, holding ponds (oil wastes), critical area seeding (roadside seeding), fencing, conservation cropping systems, stripcropping, pasture and hayland planting, grassed waterways, and crop residue management.

Structural measures to be installed consist of a floodwater retarding structure just above Baker Lake to protect both the city and the lake. The reservoir will control runoff from 4.69 square miles or 74 percent of the drainage area. This structure will eliminate about 85 percent of the average annual floodwater damages and 97 percent of the average annual sediment damages. Although the reservoir will temporarily back water over oil and gas pipelines in the upper reservoir basin following periods of intense runoff, provision is made for emergency drawdown during the summer and removal of water over the oil pipelines during the winter months.

Environmental Impact

The project will improve community conditions and strengthen overall rural area development. Flood prevention measures will reduce the amount of filth and debris that is flushed into streams and carried into homes. Contamination hazards of city wells will be reduced. Sewer backups into homes will be eliminated. The proposed structural measures are not expected to result in any measurable damage to either fish or wildlife resources.

Operation and Maintenance

The City of Baker will be responsible for carrying out operation and maintenance of structural works of improvement. Average annual operation and maintenance costs are estimated at $750.

Benefits and Costs

The cost of applying land treatment measures on private land, estimated at $11,340, will be borne by individual landowners in conjunction with assistance as may be provided under going agricultural programs.

The total cost of project structural measures is estimated at $285,380, of which $248,350 will be borne by PL-566 funds and $37,030 by other funds. The total annual benefits ($23,460) divided by total annual costs ($16,520) provides a benefit-to-cost ratio of 1.4 to 1.0.

Total project costs are estimated at $296,720. The measures will be installed during a 5-year project period.

DESCRIPTION OF THE WATERSHED

PHYSICAL DATA

The Baker Lake Watershed is located in Fallon County in southeastern Montana. The watershed contains about 4,128 acres (6.45 square miles) and includes most of the city of Baker. Baker, with a population of 2,584, is 80 miles east of Miles City, Montana, and about 150 miles north of Rapid City, South Dakota. The population of Fallon County is 4,050. Baker Lake is a shallow reservoir, with 115 surface acres, situated in the southeastern part of Baker.

The watershed is located in Water Resource Region 10, Subregion 10, OBE Economic Area 095, and Land Resource Area 059. Conditions in the watershed are similar to those watershed areas in the subregions which are near the headwaters of streams and drainageways. The watershed is near the northern portion of the Great Plains province in the extreme headwaters of the southern tributaries of the lower Yellowstone River.

The principal water resource problem in the watershed is floodwater and associated sediment production.

The drainage area above Baker Lake is 4.69 square miles, much of which is highly erosive, sparsely covered shale surface soils. Floodwater and sediment have caused serious deterioration of Baker Lake. Property located along the stream channel in Baker and around the lake is also damaged.

Cretaceous-aged bedrock of the Pierre shale formation characterizes the surface geology of the watershed. The Pierre consists of dark green to dark brown shale which weathers to a gray or brown clay of high plasticity. The topography is flat to slightly undulating. Elevation in the watershed ranges from 2,900 to 3,050 feet, mean sea level (msl).

Soils covering the watershed are formed from the Pierre shale and are erosive. The soil has a thin surface crust which is dark to grayish brown in color. The surface crust is underlain by heavy plastic clays to an average depth of two feet. Below the clay is unaltered shale. A concentrated zone of salt accumulation usually occurs at shallow depth below the surface. The soils normally have low productivity and support only scant growth of various short grasses and common sages. About 20 percent of the soils are in land capability classes III and IV with the remainder in classes VI and VII.

The climate of the watershed is semiarid. Average annual rainfall at Baker is 13.5 inches for the period of 1925-1967. About 80 percent of this rainfall occurs during the growing season, considered to be from mid-May to mid-September. Average annual water yield in the watershed is about 30 to 40 acre-feet per square mile. Intensive summer cloudbursts accompanied by hail are common. The average annual temperature is 44 degrees Fahrenheit (F.) and extremes vary from a record of minus 36 degrees F. in winter to 104 degrees F. in summer. The average frost-free period is 127 days.

The watershed extends into a large oil and gas producing field associated with the Cedar Creek anticline. This field averages about four miles wide and extends 48 miles northwest of Baker to Glendive and 22 miles southeast to the Montana-North Dakota border. There are 57 oil and gas wells in the watershed.

Much of southeastern Montana has surface or near surface coal deposits; however, coal deposits in Fallon County located near or on the surface were largely burned during earlier geologic periods. No deposits of coal in the watershed are mined and existing deposits are too small or too deep to be feasibly mined.

Water development in the watershed consists primarily of surface ponds, reservoirs, and shallow wells. Shallow wells are possible only in areas where there has been an alluvial deposit which is generally along a drainageway. Deep wells would have to penetrate the Pierre shale formation which, in most cases, is more than 3,000 feet thick.

Supplies of good surface water are limited in the watershed. The need for water by the railroad in early years prompted the construction of Baker Lake dam in 1908 below a good spring. Baker Lake provided an average of 16,000 gallons of water per day for the Chicago, Milwaukee, St. Paul and Pacific Railroad during the years 1920-1929. Baker Lake is the only water facility that is large enough for public recreational use within 80 miles of Baker.

The dam impounding Baker Lake is about 1,100 feet long, 40 feet wide, and has a maximum height of 25 feet. The crest of the dam serves as the roadbed for State Highway #7. The dam has a 40-foot wide reinforced concrete chute emergency spillway. See Plate #1. The original storage capacity of the reservoir was about 756 acre-feet. This capacity has been reduced by sedimentation to approximately 250 acre-feet. Measurements taken in the years 1937, 1955, and 1970 indicate a steady delivery rate of 1.74 acre-feet per square mile per year.

Land use in the watershed consists of (1) rangeland, 2,803 acres (68 percent); (2) cropland, 441 acres (11 percent); (3) urban, 503 acres (12 percent); (4) airport, 188 acres (4 percent); (5) Baker Lake, 115 acres (3 percent); and (6) roads and miscellaneous, 78 acres (2 percent). The range condition is about 50 percent fair and 50

percent good. Because of the soil and climate conditions that exist, it can improve only very slowly. Range plant species include little bluestem, blue gramma, buffalo grass, western wheatgrass, salt grass, sagebrush, greasewood, rose bushes, rubber rabbitbrush, and various salt tolerant forbes. Vegetation is sparse with a high percentage of exposed soil.

The watershed is drained by an unnamed tributary to Sandstone Creek which flows into the Yellowstone River. The drainage begins at a low divide, elevation 3,050 msl, four miles southeast of Baker. It flows northwesterly through Baker Lake, thence west through Baker and joins Sandstone Creek, elevation 2,900 msl, just below the city limits. The area is oval in outline and slopes inward and northward. The topography is relatively flat and uniform, having an average inclination of 30 feet per mile. Stream classification for these drainageways is "N" (well defined channel) and "E" (Ephemeral--flows only at time of surface runoff). Streams in this area are classed as $B\text{-}D_3$ by the Montana Water Pollution Control Council.1/ The main drainage channel above Baker Lake consists predominantly of a series of small scoured waterways. The creek from Baker Lake through the city is the only channel which has been modified by man and is stable.

E C O N O M I C   D A T A

Baker is the county seat of Fallon County. It is a central trade community for a five-county area of southeastern Montana and southwestern North Dakota where livestock ranching and oil and gas production are the principal industries. There are local grain elevators, farm service facilities, and wholesale and jobber outlets.

The population of Baker, according to the 1970 census data, is 2,584. Baker has made steady growth during the past 20 years. The 1950 population was 1,772 and the 1960 population, 2,365. Fallon County also has grown since 1950 when the population was 3,660. The 1970 county population is 4,050. Virtually all the population in Baker is within the watershed. The watershed population, including the rural residences and ranch headquarters, is estimated at 2,572.

Lands in the watershed are privately owned except for 515 acres owned by the City of Baker, 640 acres owned by Fallon County, and 240 acres of federal land administered by the Bureau of Land Management.

1/ State Classification BD_3 indicates water suitable for water contact sports, waterfowl and furbearers, and non-salmonid fishes and associated aquatic life. With adequate treatment, this water may be used for domestic purposes.

Livestock ranching and wheat farming are the basic agricultural enterprises in Fallon County and in the watershed. Mineral production (primarily oil and gas), however, exceeds the value of agricultural products. The value of mineral production in 1968 for Fallon County was 19.7 million dollars. Crude oil production was 8.4 million barrels. Crude oil reserves are estimated at over 100 million barrels. The market value of crops according to the 1969 Census of Agriculture was 2.0 million dollars. The value of livestock and livestock products was 4.2 million dollars.

All of the ranch lands in the watershed are parts of larger farm and ranch enterprises. There are two ranch headquarters in the watershed and parts of eight ranches. Average per acre yields of the dry land crops are: wheat, 30 bushels; barley, 29 bushels; and tame hay, 0.75 ton. Animal stocking rates on rangeland average about 0.075 animal unit months per acre. The average size farm in Fallon County is 2,993 acres. Of the farms with sales over $2,500 in 1969, 31.2 percent had sales less than $10,000.

About 83 percent of the farms and ranches in Fallon County are family owned and operated. Agricultural statistics indicate that of the 288 farms with income over $2,500 in 1969, 154 farms or 53.5 percent had hired labor for periods of less than 150 days per year. A total of 46 farms or 15.9 percent had hired farm labor for periods of 150 days or more during the year.

In Fallon County there are 233,213 acres of cropland; 651,175 acres of rangeland; and 25,224 acres of forest, pasture, and other lands. Rural land values in the Baker area are typically $75-$100 per acre for dry cropland and $35-$50 per acre for rangeland. Subdivided tracts in the watershed near Baker are listed at $1,000 per acre. Most of the watershed outside of Baker is rural, and typical rural land prices prevail.

With the steady urban growth that has been present in Baker over the past years, Baker has had an active real estate market. Improved vacant lots typically sell for around $2,000. Generally, older homes have been selling from $10,000 to $15,000. Most newer homes, including new construction, range from $18,000 to $23,000.

Urban growth trends indicate that residential growth will continue in the southern and eastern parts of Baker. A limited amount of residential development has taken place east of Baker Lake and is expected to continue.

A park has been proposed for part of the city-owned area near Baker Lake. The location of a park in this area is being studied in the comprehensive city plan now under way. Other city owned lands include the airport.

Lands owned by Fallon County are in the central portion of the watershed near the upper end of Baker Lake and contiguous with city owned lands. These lands are used for fairgrounds, maintenance shop facilities and part is grazing land.

Census data for Fallon County indicate that in 1970 there were 1,540 persons in the labor force, with 94.6 percent employed and 5.4 percent unemployed. Employment in the labor force was distributed percentagewise as follows: agriculture, 22.0; mining (oil and gas), 12.0; construction, 6.2; manufacturing, 1.5; transportation and communication, 1.6; utilities, 5.5; wholesale, retail, food, and service, 32.2; financial and credit, 2.3; schools and government, 7.6; and private householders and other, 9.1. The number of people employed in agriculture decreased 24.0 percent from 1960 to 1970, while non-agricultural employment increased 23.8 percent. Unemployment normally increases in late fall and winter due to farm and construction layoffs. Oil and gas activity is expected to remain stable.

Census data show that the annual median income in Fallon County in 1969 was $8,888. Annual mean income was $8,530 and per capita income, $2,439. It is also shown that 11.5 percent of the families are considered to be in the poverty category. The mean family income of this group is $1,130 and the mean income deficit, $1,416.

FISH AND WILDLIFE RESOURCE DATA

The watershed and Baker Lake support small wildlife populations, including some furbearing and big game animals, game and non-game birds, and a few fish. The area is inhabited by mule deer, antelope, waterfowl, sage grouse, sharptailed grouse, grey partridge, and rabbits. These animals provide public hunting in the non-urban area. Mourning doves commonly nest in the area and, although Montana law does not permit dove hunting, these birds contribute to hunting in other states. Large raptors, including golden eagles, patrol the area, and coyotes, skunks, and a variety of small birds, mammals, amphibians, and reptiles are common inhabitants of the area.

Many song and insectivorous birds nest in the area, and many other migratory species pass through during both the spring and fall migration periods.

Fishing in Baker Lake is limited to warm, shallow water fishing for rough species such as bullheads and carp. Recreational game fishing is non-existent due to the sedimentation which has occurred in the lake.

These fish and wildlife resources provide year-round recreation for young and old alike in the form of hunting, trapping, fishing, wildlife watching, and photography.

Year-round public access is available to Baker Lake. County roads and oil field roads provide access to the upper watershed; however, use of this area is primarily controlled by private land owners.

RECREATIONAL RESOURCE DATA

Recreation and public recreational facilities are limited in the watershed. In particular, there is a shortage of water-based recreational facilities.

Baker Lake has served as a recreational center for a multi-county area. It is the only water-based recreational facility within 80 miles of Baker; however, use of the lake has deteriorated due to sediment deposition. Throughout the years, the City of Baker has built around the lake and has many lakeshore home developments that are now subject to devaluation if the lake continues to fill with sediment. Discharges from Baker Lake flow through the highway bridge, the spillway, and the watercourse through the city below.

Baker Lake is normally filled each spring with early season runoff. Lake levels are partially maintained by springs which offset some of the normal evaporation and seepage losses. This adds to the recreational value of the lake. Lake levels have fluctuated from as much as five feet above the spillway when flood flows from the upper watershed have passed through the lake, to two feet below the spillway at the end of the summer. Normal fluctuations of the lake level are from two feet above the spillway to two feet below. Levels of two feet or more above the spillway create flooding problems to shore line property.

Recreational use of the lake has declined over the years, but includes limited amounts of fishing, ice skating, snowmobiling, boating, and water skiing.

Swimming was abandoned about five years ago due to sedimentation in the lake. It is estimated that the lake now provides only about 3,090 visitor days use annually. Use of the lake is severely restricted after midsummer because of its shallow depth and resulting weed growth. The average depth of the lake is now 2.6 feet.

Most of the development immediately adjacent to Baker Lake has been for home sites. However, there are a few commercial businesses. Additional home sites are being developed near the upper end of the lake.

Local interest is strong for reclamation and further development of Baker Lake once it is protected from floodwater and sedimentation that now exist. Interest in the development of this facility includes the reclamation of about 80 acres of the lake by dredging and installation of recreational facilities on city owned land near the lake. Although the lake is accessible to the public from the highway, streets, and city land, public boat launch facilities need to be developed.

ARCHEOLOGICAL AND HISTORICAL VALUES

An archeological survey of the area immediately above Baker Lake was conducted by the University of Montana Statewide Archeological Survey. A single damaged hearth, two projectile points, and a one-edge scraper were recovered from the area. All items were unrelated. No significant antiquities in the watershed will be endangered by the development of the proposed project. The watershed does not contain any places listed on the National Register of Historic Places.

SOIL, WATER, AND PLANT MANAGEMENT STATUS

The Baker Lake Watershed is entirely within the Little Beaver Conservation District. Land owners and operators receive assistance from the District to apply land treatment measures.

Present land use patterns have existed over many years and are expected to continue during the project period. The most common land treatment practices include strip cropping, pasture and hayland planting, proper grazing use, and holding ponds for oil well wastes.

In the watershed there are 2,425 acres of private lands under agreement with four cooperators. One cooperator has a Conservation Plan and a Great Plains Conservation Plan. In addition, the City of Baker and Fallon County are both cooperating with the Little Beaver Conservation District on 1,155 acres through the development of this Work Plan. Another 240 acres managed by the Bureau of Land Management are also under a conservation plan. These agreements account for 3,810 acres or 92 percent of the watershed.

About 32 percent of the needed land treatment practices, based on a dollar value, have been applied. This represents 80 percent of the presently planned practices. Active programs, including the Rural Environmental Assistance Program (REAP) and Great Plains Conservation Program (GPCP) are available to encourage the application of land treatment measures in the watershed.

WATERSHED PROBLEMS

LAND TREATMENT

Sediment production in the upper watershed has been high. Vegetative cover is generally sparse and difficult to establish on the shallow, clayey soils weathered from shale. Much of the upper watershed was used as a community pasture during the early 1900's and overgrazing often resulted. Even with better grazing practices in recent years, sediment rates have remained constant. There is a need to continue to improve range condition in an effort to reduce sediment production.

Oil and gas exploration activities have been carried on in the upper watershed. Additional holding ponds should be established to trap waste oil from some of the wells. Areas along the service roads that cross the watershed should be seeded.

FLOODWATER DAMAGES

The principal watershed problem is flooding. Sediment laden floodwater from the upper watershed causes extensive damages along the watercourse through the City of Baker and Baker Lake. Intense spring and summer rains, usually of short duration, produce more damaging runoff than snowmelt. Flooding occurs most often in the spring and early summer, when the lake is full, although there are occasional severe mid-summer rainstorms.

Floodwater causes many problems for people in Baker. Some homes around the lakeshore are flooded nearly every year. Lake levels as high as five feet above normal have been observed during more severe storms. Floodwater problems also occur below Baker Lake in a level floodplain area that is about one block wide through the city. During large storms, all street crossings of the channel are flooded. In addition, State Highway 7, which crosses the dam, is overtopped south of the dam. When these streets are flooded, traffic flow between the two parts of the city is interrupted. Residents in the north and east parts of the city and the business district are cut off from the southwest part where the hospital, schools, and most churches are located. Other floodwater problems below the lake include flooding and sewer backups to homes and businesses, city streets and park damages, water over city wells, and damages to bridges and fences on U. S. Highway 12 west of Baker. Damages such as sewer backup extend outside the flooded area. There are about 55 homes in Baker that are subject to flood damages from the upper watershed, including 11 homes around Baker Lake. These conditions create many potential health hazards for the entire city. These unhealthful conditions caused by floodwater contribute to an overall lower quality of environment.

Damaging rainstorms exceeding two inches in a 24-hour period occurred in the years 1930, 1933, 1941, 1943, 1947, 1955, 1963, and 1971. The 1971 flood and the major flood of 1955 are the most prominent recent floods.

The flood of June 26, 1955, was caused by a sudden evening rainstorm that dumped 4.0 inches of rain in a 24-hour period. Rain during the next two days added 1.32 inches of precipitation. Damage interviews with residents in the watershed indicate that damages exceeded $36,000 based on 1971 prices. Some additional damage occurred in Baker outside the watershed from the adjoining Sandstone Creek. Damages in the watershed included flooded basements, one bridge washout, sewer backups, closed and damaged streets and highways, foundation damages, a telephone cable break, water over city pumps and wells, and stranded motorists. Traffic between the two parts of the city was interrupted because all connecting streets were closed. Families were forced from their homes and, in addition, tourists in two motels were forced to give up their rooms. Flooding occurred all along the watercourse and around Baker Lake. This flood is estimated to have a frequency of occurrence of once in 50 years.

The flood of June 4, 1971, also was the result of a sudden rainstorm. About 2.7 inches of rain fell between 4 p.m. and midnight. Flooding occurred to homes around Baker Lake from the high lake levels. Flooding also occurred to homes, businesses, streets, and parks along the watercourse through Baker. Much of this damage, including the sewer backups into basements, was caused by runoff from the watershed above the city. Interviews with residents, business proprietors, and city officials following the storm indicated that about $9,000 of damage resulted. This storm is estimated to have a frequency of occurrence of once in 10 years.

The largest flood expected to occur once in 100 years would raise the level of Baker Lake to elevation 2939.5, which would be 5 feet above the crest of the lake spillway. This would cause extensive flood damages to homes around the lake, overtop the highway, and endanger the dam. Flood flows would continue downstream through Baker causing damages that would be greater than those experienced in the 1955 flood. About 55 homes would be directly in the damage area along with 10 businesses and other properties which would be affected by sewer backups and related flooding problems. Other property includes two highways and highway bridges, three streets, two parks, and utilities. Damages from this 100-year storm would be expected to exceed $46,000. The value of residential and commercial property in the damage area is estimated at more than $921,000.

Some growth and development in the floodplain is expected in the coming years. New homes are currently being built around Baker Lake and on the floodplain. Areas like these are being considered for developments such as retirement homes where large tracts of land close to the city area are desired. Considerable development has taken place in the past 15 years. Continued changes expected to occur within this area include new homes, expansion of businesses, some residential use changed to commercial, and the increase in business inventories and damageable property.

Floodwater entering the upper end of Baker Lake along with the resulting lake level fluctuations has also curtailed the construction of an access route that would connect the eastern part of Baker directly with the schools, churches, courthouse, airport, etc., in the southwestern part of the city. The alternate route to connect these two parts of the city would facilitate normal traffic patterns. However, availability of the route would be questionable during a flood unless it were adequately protected.

Average annual damages attributed to overland floodwater flow are estimated at $7,320, including $2,200 residential, $3,660 commercial, $1,460 for streets, highways, and bridges. In addition there are $1,460 of indirect average annual damages, including such things as detours and delays of residents and travelers, interruptions of utility and communication services, and disruption of normal community activities. See Table 5.

SEDIMENT AND EROSION DAMAGES

A second major watershed problem is high sediment yield. Sediment has rapidly depleted storage in Baker Lake by about one percent per year since construction of the dam in 1908. The original lake capacity of about 756 acre-feet has been reduced to about 250 acre-feet. The measured sediment yield of the watershed at Baker Lake is 1.74 acre-feet per square mile per year. The heavy accumulation of sediment in Baker Lake now prevents storage of normal seasonal runoff and is decreasing the sediment trap efficiency. Increased amounts of sediment are being deposited in the channel and floodplain area below the lake.

Sheet erosion is the predominant source of sediment. Rapid runoff from the drainage area above the lake occurs during and following high intensity rainstorms. The runoff is high because of heavy saline soils with low water intake rates and sparse vegetative cover. Although soil cover conditions have improved in the watershed area, sediment yield has continued to be high. Storage is needed to trap the sediment load before flows reach Baker Lake.

The recreational and aesthetic qualities of Baker Lake have been reduced as the result of sediment deposition. Swimming as a recreational activity was abandoned in 1965. Boating use is limited to high reservoir stages during the early part of the season. These activities have been severely restricted because of extensive sediment deposits which have brought about shallow warm water and fostered shoreline weed growth. Use of the lake is being reduced to the point where it borders on being a detriment to the community and lakeshore property owners. As the lake continues to be depleted by sediment deposits, property values near the lake will be greatly reduced. The attractiveness of the entire community will decline. Recreational use of the lake is expected to be virtually nonexistent in 15-25 years. The present lake condition has delayed the development of a city-county park on public land adjacent to the lake.

Total average annual sediment damages without the project are estimated at $13,420. Sediment damages amounting to $7,470 annually to Baker Lake and adjoining property are based on $4,350 average annual depreciation to lakeshore homes and $3,120 of recreation values lost in Baker Lake. Overbank sediment deposition damages, estimated at $5,950, will occur below Baker Lake and become progressively worse as the lake fills with sediment. Annual operation and maintenance costs for sediment removal from the channel are estimated at $3,100. Property depreciation along the channel is estimated at $2,850.

RECREATION

Baker Lake has been an important water recreational facility in an area of southeastern Montana where this type of facility is scarce. Water-based recreation has great appeal because of high summer temperatures. Other recreation opportunities are also limited in the area. There is strong local interest for reclamation of Baker Lake and a joint City-County park development for land along the south shore of the lake. Additional discussion of recreation problems is presented in the section on Sediment Damages.

FISH AND WILDLIFE

Fishery habitat in Baker Lake has been severely reduced due to sedimentation. Fishing is limited to rough species. The existing fishing use made of the lake is expected to decline with further sedimentation. An assessment of these losses is included in the discussion on Sediment Damages.

ECONOMIC AND SOCIAL

Economic and social problems in the watershed include threat of population loss due to migration of people to larger cities, underemployment, seasonal unemployment, potential loss of property tax base, and a significant percentage of families in the poverty status.

The population growth trend experienced in Baker over the past 20 years and the City's importance as a distribution and service center are related to a good community environment enhanced by an attractive lake. Economic and social problems in Baker will increase with the further degradation of Baker Lake.

PLATE 1

SCS Photo

Baker Lake Spillway discharging during the minor rainstorm of April 21, 1971. Water was about 0.3 foot deep across the 40-foot crest.

SCS Photo Mt-P514-11

The Baker Lake Spillway, built in 1914, is due for replacement in the near future. The Montana Highway Department has this maintenance responsibility. Cost savings for maintenance or replacement should be realized with the Watershed Project.

PLATE 2

SCS Photo

Flooding occurs nearly annually at the Baker ballpark. Photo taken April 21, 1971.

SCS Photo

Floodproofing attempts shown here were inadequate to hold out the high lake level reached June 4, 1971. Water was one foot deep at garage door.

PLATE 3

SCS Photo

Water overtops West Third Street nearly annually. The above photo shows flows during the April 21, 1971, storm. The photo below shows the damage resulting from the June 4, 1971, storm when water flowed midway between the two lower horizontal bars on the bridge. Although the street was built to accommodate overtopping, substantial maintenance costs are incurred.

SCS Photo

PLATE 4

SCS Photo Mt-P513-16

Channel improvement around the ballpark and through the city park is needed to reduce flooding problems.

SCS Photo Mt-514-2

PLATE 5

SCS Photo Mt-P513-1

Photo shows dam site above Baker Lake. Centerline of dam will follow fence in the foreground and bend right toward oil well. This dam will trap sediment and provide floodwater retardation to protect Baker Lake and property in Baker.

SCS Photo Mt-P513-2

Photo shows area above proposed dam. Sparse vegetation and saline soils as shown in the background are typical of the upper watershed.

PROJECTS OF OTHER AGENCIES

A comprehensive plan for the City of Baker is being developed. This plan is being sponsored by the City of Baker and Fallon County in conjunction with a planning grant from the Department of Housing and Urban Development. This plan is to include a feasibility report for reclaiming Baker Lake and the development of a park and recreation complex on 745 acres of City and County owned lands around the south shore of the lake. The City and County purchased these lands in 1968 for use as a park near the lake.

There is strong local interest to reclaim Baker Lake and proceed with the associated park development. Preliminary estimates have been made for the amount of dredging that would be required to deepen about 80 acres of the present lake. In addition, a preliminary park plan has been developed for land along the south shore of the lake. Consideration is being given by local governments to make this a joint City-County venture. Final action on these plans requires the reduction of floodwater and sediment damages in the watershed.

No other resource developments are under consideration or in progress by county, state, or federal agencies in the watershed.

BASIS OF PROJECT FORMULATION

The sponsors of this watershed project submitted an Application for Assistance under PL-566 on October 7, 1968. This application was approved by the State Soil Conservation Committee on October 31, 1968. Numerous special meetings with the sponsors and public meetings were held locally during preliminary and advanced planning stages. Special information was requested from other concerned agencies and groups, including U. S. Bureau of Sport Fisheries and Wildlife, Montana Dakota Utilities, Shell Oil Company, and Butte Pipe Line Company.

Interested and concerned agencies and groups have been kept appraised of planning progress and invited to submit input suggestions.

PROJECT OBJECTIVES

The basic objective of the sponsors of this project is to reduce floodwater and sediment damages in the watershed. Protection from the largest storm expected once in 100 years from the watershed area above Baker Lake is desired. Meeting this objective is essential to improve living conditions and reduce costly flood problems. A secondary objective is to provide an opportunity to reclaim Baker Lake and further develop needed water-based recreation. Reclamation of Baker Lake will be carried out by the sponsors apart from this watershed project.

A Type 1 River Basin investigation was conducted in 1965 for the Missouri River Basin. This study did not identify specific feasible measures to solve particular needs of the Baker Lake Watershed.

Numerous alternatives were considered for solving the watershed problems. Each alternative was analyzed for its effectiveness and related impacts. The following land treatment and structural measures were determined to be the most practical for the solution of these problems. Other alternatives considered are discussed at the close of this section.

SELECTED PROJECT MEASURES

Land Treatment Measures

Land treatment measures for rangeland and dry cropland were given first consideration in attaining project objectives and lengthening the life of the project. Measures such as proper grazing use, deferred grazing, ponds, pipelines, tanks, holding ponds (oil well wastes), critical area planting (15 acres roadside seeding), fencing, conservation cropping systems, stripcropping, pasture and hayland planting, grassed waterways, and crop residue management were selected to reduce runoff and sediment production. These measures were

selected based on present land use patterns which have been stable. Future land use changes which would increase sediment rates should not be allowed.

About 78 percent of the watershed will be adequately treated by the end of the 5-year project installation period.

Structural Measures

Structural measures were considered after it was determined that land treatment alone could not achieve the project objectives. A floodwater retarding structure was examined as the first increment of structural measures for preventing floodwater and sediment damages. Consideration was given to three structure sites. These sites included locations: (1) at the present Baker Lake dam site; (2) across the upper portion of Baker Lake at the intersection of a projection of Center Avenue and Seventh Street; and (3) at a site just above Baker Lake.

The possibility of rebuilding the present Baker Lake dam was considered, but rejected. A dam at this site would have to be raised considerably to provide the necessary floodwater and sediment storage. Shoreline homes would be inundated. The existing dam would have to be completely rebuilt and the highway replaced.

The dam site suggested at the projections of Center Avenue and Seventh Street across the upper portion of Baker Lake would permanently inundate two gas wells and about one-half mile of gas line. Construction would require draining the lake along with extensive foundation preparation. The upper areas of Baker Lake would be eliminated as disposal areas for sediment resulting from anticipated dredging for lake reclamation. For these reasons this site was also rejected.

The most favorable dam site was one selected just above the upper end of Baker Lake. This site will eliminate many of the problems associated with the other two sites and is least costly to construct. An area below the site is still available for wasting dredged sediment from Baker Lake. A street crossing could be incorporated with this dam at a later date. This structure site, even though higher in the watershed basin, is adequate to meet the desired level of floodwater and sediment protection.

Sediment entrapment was given equal consideration with floodwater retardation. The sediment pool, which will provide for 100 years of sediment accumulation, will act as a settling basin. Large storms that would fill the reservoir would be automatically drawn down at a slow rate which will allow the sediment to settle and be trapped.

Runoff from smaller, more frequent storms could be temporarily stored or released at a slow rate to ensure more complete entrapment. Water which is temporarily stored would be released later to maintain the level of Baker Lake.

Provision as required by the pipeline companies was also made for rapid emergency drawdown to remove water over the gas and oil lines in case of a pipeline failure within the reservoir basin. This required the diameter of the principal spillway conduit to be enlarged from 30 to 48 inches. The outlet gates and other appurtenances were enlarged accordingly. Providing this emergency drawdown capability was much less costly than constructing dikes around or over the pipelines or relocating them. The probability of a pipeline failure being coincidental with a large storm is very remote. However, the maximum emergency discharge of about 200 cfs would not create flooding damages around Baker Lake or further downstream. A second requirement of the pipeline companies was that water would not be stored over the pipelines during the period from October 1 to April 1. This requirement necessitates drawing the reservoir down to elevation 2,939.0 feet msl by October 1.

The pipelines in the reservoir basin also preclude a recreational development in conjunction with this floodwater retarding structure. In addition, annual runoff from the watershed is too low to maintain both the reservoir and Baker Lake.

Minor channel shaping and cleaning is desirable along the watercourse through Baker in addition to the floodwater retarding structure. This work is considered normal channel maintenance by the City of Baker and is not included in the planned structural works of improvement. A larger culvert on 4th Street would reduce residual flooding from local runoff to the low park areas. However, the culvert and channel maintenance are not considered necessary to meet project objectives.

Environmental aspects were given prime consideration in the formulation of proposed project measures. Although this new dam will destroy existing wetland habitat at the upper end of Baker Lake, similar habitat will be created in the new reservoir basin. The project will not require the relocation of any persons, farm operations, or businesses. The quality of environment for people will be improved by reduction of flood damages, pollution, and filth associated with floodwater. This project will provide the opportunity to reclaim Baker Lake; thereby improving its condition and enhancing recreational opportunities. This project will enhance fish and wildlife habitat in Baker Lake by reducing sedimentation and improving water quality.

OTHER ALTERNATIVES

Land Treatment Only

Conservation land treatment measures alone were considered as a solution to the watershed problems. These measures are essential for protection of the watershed area; however, due to soil and climatic conditions, they will not adequately control flooding and sedimentation.

Flood Proofing

Flood proofing would be practical for only a limited number of houses and businesses in Baker. It would not solve the sediment problem. Many other flood problems affecting the community such as sewer backups, pollution problems, and health hazards would remain. The environmental impact to fish and wildlife from this alternative would be negligible. This alternative was not considered to be feasible.

Channeling and Diking

Channeling and diking measures would be limited to the channel area below Baker Lake. These measures would not protect property around Baker Lake nor prevent the sediment buildup in the lake. These measures would have many adverse impacts to wildlife and aesthetic values and were not considered feasible.

Land Use Regulation (Zoning)

Land purchase or floodplain zoning could be used to prevent flood damages to future development. This would not help present developments nor stop deterioration of Baker Lake. Nothing would be done to halt the pollution and filth now associated with flooding. Wildlife environment would be enhanced since more area would be returned to, or left in, a natural state. The impact of zoning on people living in the flood prone area would be adverse. Persons moving out, if not compensated, could suffer a severe economic loss. Even with compensation, older persons might be inclined to stay in their homes. Many of the health hazards and flood problems would continue.

Floodplain Insurance

Floodplain insurance could offset some flood losses. However, this would do nothing to alleviate the deterioration of Baker Lake nor stop pollutants, filth, and debris that now wash into the damage area. Environmental impacts would be negligible.

WORKS OF IMPROVEMENT

TO BE INSTALLED

LAND TREATMENT

The most important land treatment measures planned for non-federal lands in the watershed are aimed at reducing erosion and improving water infiltration on rangeland and dry cropland. Conservation plans, Great Plains Contracts, and soils surveys will be developed to facilitate the installation of land treatment measures.

Land treatment measures to be installed on dry cropland include conservation cropping systems, stripcropping, pasture and hayland planting, grassed waterways and crop residue management.

Land treatment measures to be installed on rangeland include proper grazing use, deferred grazing, ponds, pipelines, tanks, fencing, critical area plantings (roadside seeding) and holding ponds (oil wastes). Since some of these measures are recurring practices on an annual basis, all of the rangeland and dry cropland in the watershed will be included.

The estimated cost of land treatment measures, including technical assistance, is $11,340. See Table 1.

STRUCTURAL MEASURES

A floodwater retarding structure is planned just above Baker Lake. It is designed so that the crest of the principal spillway riser is at the top of the 100-year sediment pool and has an ungated outlet 18 inches square at the top elevation of the 50-year sediment pool. The upper half of the sediment pool will drain slowly so the suspended sediment will have time to settle out. See Figures 1 and 3 for typical dam cross-sections and location.

The foundation of the dam will be excavated to shale bedrock and the principal spillway will be on an unyielding foundation.

The principal spillway will consist of a reinforced concrete riser and a 48-inch diameter prestressed concrete steel cylinder type conduit located in the left abutment of the dam. The outlet of the conduit will be cantilevered and rock riprap will be used to prevent scour. Normal maximum discharge is planned to be 36 cubic feet per second (cfs), controlled by an orifice at the inlet of the barrel, when the reservoir is at maximum stage. The discharge for an emergency drawdown to remove water over the gas and oil lines in the reservoir basin in case of a pipeline failure would be 186 cfs if the water elevation is at the crest of the riser (2,947.6 feet msl). The emergency discharge would be 218 cfs with the water at the crest of the emergency spillway (2,951.0 feet msl).

The rectangular open-top riser will have inside dimensions of four feet by six feet. It will extend from elevation 2,936.0 feet msl to 2,947.6 feet msl, a distance of 11.6 feet. The riser will have a 48-inch square gate at the bottom and an ungated 18-inch square opening at elevation 2,944.0 feet msl. Both openings will be on the front side. All inlets will have trash racks.

A 48-inch square orifice barrel gate will be installed inside the riser at the inlet of the conduit, but will be permanently blocked, partly open, for orifice control. Both gates can be opened for emergency drawdown as well as for operation and maintenance. The gates will be operated by enclosed gear pedestal lifts which will be accessible by means of a catwalk from the dam to the riser. Trash racks will be installed to prevent malfunction from debris.

The conduit will be constructed with a reinforced concrete cradle, anti-seep collars, and a double column bent at the outlet.

The dam will have a vegetated emergency spillway located in each abutment. The left spillway will be 250 feet wide and the right will be 300 feet wide. Each spillway will have a 200-foot long level section. The combined discharge capacity will be 9,130 cfs.

The structure is designed to control the maximum storm expected in 100 years and the emergency spillways will function less than once in 100 years.

The dam will be constructed of compacted earth fill. See Figure 1. It will have an upstream zone of select material and a downstream zone of shale material. A gravel blanket drain with a pipe outlet will be placed in the downstream zone just above the expected maximum water surface of Baker Lake.

The total volume of embankment, including foundation backfill, is estimated at 103,500 cubic yards. The dam will be 1,540 feet long, 22 feet high, with a top width of 12 feet. The upstream slope is planned to have a slope of 4 to 1 and be protected by a gravel blanket 2.5 feet thick up to elevation 2,951.0 feet msl. The remaining slope and top of dam will be covered with pitrun gravel one foot thick. The downstream face is planned to have a slope of 3 to 1. This slope will be protected with a layer of topsoil and vegetated. Waste material will be placed near the toe for further protection.

About 500 feet of barbed wire fence will need to be removed from the dam site.

The project is designed to have a 100-year life and the 50-year sediment pool (408 acre-feet) will initially store water.

The reservoir will control runoff from 4.69 square miles or 74 percent of the drainage area.

The reservoir will have a total capacity of 1,460 acre-feet with a surface area of 238 acres. It is approximately three-eighths mile wide and a maximum depth of 18 feet. The capacity is proportioned to provide for a 50-year sediment storage of 408 acre-feet at elevation 2,944.0 feet msl; a second 50-year sediment storage of 408 acre-feet at elevation 2,947.6 feet msl; and 644 acre-feet of floodwater storage at elevation 2,951.0 feet msl. This floodwater storage will contain the maximum storm expected once in 100 years.

One oil well belonging to Shell Oil Company in the reservoir basin will have to be raised. Waste material from the foundation and spillway excavation will be disposed of near this well at no additional cost so that it can be utilized to build a new pad and access road. Any additional waste material from the spillway excavation will be placed at the downstream toe of the dam.

About 250 feet of gas collection line that crosses the right emergency spillway will have to be lowered.

About 1,200 feet of an oil field service road in the upper part of the reservoir basin should be raised two feet at the low point to elevation 2,948.4 feet msl (about one foot above the crest of the principal spillway riser). Hydrologic evaluations indicate that water should reach the road elevation very infrequently during the life of the project.

Borrow materials will be shallow but can be obtained from excavation of emergency spillways and from a 30-acre area near the dam. The borrow areas will be smoothed and planted with grass, trees, and shrubs to reduce erosion, provide wind protection, and create esthetic surroundings.

The installation of the dam and reservoir will require the commitment of 267 acres. Of this, 29 acres are needed for the dam and spillways, 86 acres for first 50-year sediment pool, 70 acres for second 50-year sediment pool, and 82 acres for flood storage above the sediment pools. The acquisition of land rights can be accomplished without the relocation of any farmstead, home, or business. The lands acquired from private owners will not create uneconomic farm or ranch remnants.

Incidental recreational use of the reservoir may be made only during the period when the reservoir is frozen over. Any activities such as boating, or use of all-terrain vehicles during periods when the reservoir is not frozen, are to be prohibited, since these activities will tend to keep the water turbulent and delay sediment deposition.

No special provisions for safeguarding public health, sanitation, or safety have been provided.

The estimated cost of these structural measures is $191,500.

EXPLANATION OF INSTALLATION COSTS

LAND TREATMENT MEASURES

Installation cost of land treatment measures as shown in Table 1 totals $11,340. This total represents both application and technical assistance costs.

STRUCTURAL MEASURES

Total costs of structural measures include construction, engineering services, land rights, and project administration. All installation costs are allocated to flood prevention.

Construction

The total construction costs for the project are estimated at $191,500. This cost includes clearing right-of-way, foundation and emergency spillway excavation, construction of embankment and principal spillway, shaping and seeding of disturbed areas, and disposal of waste and spoil material. A contingency allowance of 15 percent is included to allow for unforeseen costs. See Tables 1 and 2.

Engineering Services

The cost of engineering services, estimated at $22,980, includes the direct cost of engineers and other technicians for surveys, investigations, design, and preparation of plans and specifications for structural measures, including associated vegetative work.

Project Administration

Project administration costs, estimated at $34,470, include contract administration, review of engineering plans prepared by others, government representatives, construction surveys, and all necessary inspections during construction that are required to ensure installation of structural measures in accord with plans and specifications.

Land Rights

The total of land rights costs for the project is estimated at $36,430 and includes the following items. A total of 185 acres will be required for the dam, emergency spillways, and sediment pool at an estimated cost of $9,250. This area includes 105 acres of private land, 74 acres of County land and six acres of City land. Acquisition costs, including surveys, legal fees, etc., are estimated at seven percent of the value of lands acquired or $650. A flood pool easement for 82 acres, which includes six acres of private land and 76 acres of County land, is estimated at $1,030. Gas field modifications

are estimated at: (1) $23,000 to raise Shell Oil Company Well No. 24-18; (2) $500 to replace 250 feet of gas pipeline belonging to Montana Dakota Utilities Company; (3) $1,500 to raise 1,200 feet of oil field service road; and (4) $500 to install valves on Butte Pipe Line Company oil line. The acquisition of these lands will not require the relocation of any person, farm, or business and constitutes only minor portions of large ranch units.

COST SHARING

Installation cost will be shared between the local sponsors and the federal government according to the requirements of Public Law 566 as amended and the Policy Statement of the Secretary of Agriculture. All construction and engineering service costs will be borne by Public Law 566 funds. Land rights costs will be borne by other funds.

Public Law 566 Funds

The following costs will be borne by Public Law 566 funds:

1. All of the construction costs for the floodwater retarding structure, estimated at $191,500.

2. All engineering service costs for the floodwater retarding structure, estimated at $22,980.

3. Project administration costs incurred by the Service, estimated at $33,870.

Other Funds

The following costs will be borne by other than Public Law 566 funds:

1. All land rights costs for land purchases, easements, rights-of-way, and utility relocations estimated at $36,430.

2. Project administration costs incurred by the sponsors estimated at $600.

EXPENDITURES BY FISCAL YEARS

The estimated expenditures of funds by fiscal years is shown in the table on the following page.

OBLIGATION OF FUNDS BY FISCAL YEARS

Baker Lake Watershed, Montana

	1st Year		2nd Year		3rd Year		4th Year		5th Year	
	PL-566	Other	PL-566	Other	PL-566	Other	PL-566	Other	PL-566	Other
Land Rights										
Floodwater Retarding Structure		10,000		11,500		11,500		3,430		
Construction										
Floodwater Retarding Structure			105,500		83,500		2,500			
Engineering Services										
Floodwater Retarding Structure	15,360		5,000		2,620					
Project Administration										
Floodwater Retarding Structure										
Construction Inspection			9,130		8,000		1,500		520	
Overhead	4,000		4,680		2,000		810			
Contract Administration			1,630	400	1,000	200	600			
Subtotal	19,360	10,000	125,940	11,900	97,120	11,700	5,410	3,430	520	
Land Treatment										
Construction Cost & Technical Assistance		1,340		2,500		2,500		2,500		2,500
TOTAL	19,360	11,340	125,940	14,400	97,120	14,200	5,410	5,930	520	2,500

EFFECTS OF WORKS OF IMPROVEMENT

The principal effects of installing the Baker Lake Watershed Project will be: (1) the reduction of floodwater and sediment damages to homes, streets, roads, businesses, utilities, and Baker Lake; (2) prevention of future property depreciation along the watercourse and around Baker Lake; (3) enhancement of opportunities for future reclamation of Baker Lake and the associated development of a nearby recreational facilities area; (4) a reduction in sediment production and runoff rates from the watershed; and (5) overall improvement of environmental quality. The development of this project is essential to the most efficient use of soil, water, and human resources.

FLOOD PREVENTION, EROSION, AND SEDIMENT

The watershed project will greatly reduce floodwater and sediment damages in Baker and Baker Lake.

The area flooded by a 100-year storm will be reduced by 30.8 acres. See Urban Floodplain Map, Figure 2. Average peak flows for this storm will be reduced from 675 cfs to 290 cfs. The area flooded by a 10-year storm will be reduced by 13.4 acres and average peak flows will be reduced from 320 cfs to 160 cfs. Average flood stages in the city will be reduced by 1.0 feet. Traffic flows will be able to continue without interruptions. The stage of Baker Lake during the 100-year storm will be reduced from elevation 2,939.5 feet msl to 2,937.2 feet msl. Overtopping of the highway south of Baker due to high lake stages such as occurred in 1955, and which would occur during the larger 100-year storm, will be prevented. Similarly, lake stages during the 10-year storm will be reduced from elevation 2,938.2 feet msl to 2,936.7 feet msl. Flows through the Baker Lake spillway normally begin when the lake is about at elevation 2,935.0 feet msl.

The project will provide a 100-year level of protection to the urban area in Baker and Baker Lake from floods originating above the lake.

Storms such as the 1955 storm which did major damage would be controlled. Flooding would be limited to the low park areas.

Minor flooding along the watercourse through the city is still expected as a result of local runoff. This residual flooding will be confined primarily to low park areas. Flood duration of large storms at Monroe Street will be reduced, although peak flows will be essentially unchanged since this area is affected primarily by runoff from the urban area. Less flooding will occur to street crossings in Baker. Flooding on 4th Street would be eliminated

for all storms including the 100-year storm. The continued use of low areas in Baker for parks is recommended since local street runoff will continue to flood these areas.

Land treatment measures in the upper watershed are designed to improve rangeland condition. These measures, along with those applied to dry cropland, will help reduce runoff and sheet erosion, the main source of sediment. Although sediment storage in the reservoir has been based on measured sediment yields, land treatment measures are expected to reduce sediment production and thereby reduce some sediment damages and lengthen the life of the project. Holding ponds, applied as a land treatment measure to trap oil wastes, will prevent possible pollution in Baker Lake and downstream areas.

The project will eliminate about 85 percent of the average annual floodwater damages that are now occurring in the problem area. It is estimated that at least 90 percent of the sediment will be trapped in the floodwater retarding structure with about a 97 percent reduction in sediment damages. The total area benefited as a result of the project will be about 185 acres.

The project will also halt the deterioration of Baker Lake. Property depreciation to homes and businesses around the lake will be prevented. If the lake were allowed to fill with sediment, present recreational use of the lake would be lost. The lake would become a 120-acre mud flat and mosquito breeding area. Additional damages would occur along the watercourse below the lake in the form of property depreciation and increased City maintenance costs due to increased amounts of sediment discharged. These problems and losses will be prevented by the project.

More than 55 homes having a population of about 200 and 10 businesses will be directly benefited by a reduction of floodwater flows. The whole city of Baker, as well as other residents in Fallon County and neighboring counties, or more than 4,000 persons, will be benefited through the enhancement of recreational opportunities in the protection of Baker Lake. Opportunities for the pending future reclamation of the lake will be enhanced, which will include increased recreational use of the lake and an adjoining recreational facilities area. The beneficial effects of sediment entrapment and flood prevention will extend below the watershed.

Flood prevention measures will also reduce the amount of filth and debris that is flushed into streams and carried around homes and business places. Contamination hazards of city wells will be reduced. Filth, disease, and costly cleanups in homes and businesses caused by sewer backups will be eliminated.

Water quality in the watershed will be improved by the reduction of transported sediment and associated pollutants.

The reduction of overland flows in low areas that become ponded will reduce mosquito breeding places which are potential vector sources.

FISH AND WILDLIFE

The proposed structural measures are not expected to result in any measurable damage to either fish or wildlife resources.

The 29 acres on which the dam will be located includes about six acres of cattail-wetland marsh. The loss of this wetland area will be offset by the creation of similar habitat above the new dam.

The reservoir will be located on a poorly defined ephemeral stream basin. The 100-year sediment pool will inundate 156 acres of open rangeland. The maximum flood pool can temporarily inundate an additional 82 acres.

The project will protect Baker Lake from further degradation by sediment and make possible the reclamation of the lake.

Water levels in Baker Lake will be stabilized and water quality improved. This will enhance existing fish and wildlife habitat.

All disturbed land areas will be reseeded, including emergency spillways and construction and borrow areas. The borrow areas will be recovered with topsoil and trees and grasses will be established to restore and improve the wildlife habitat. This will also enhance the esthetics of the watershed area.

ARCHEOLOGICAL AND HISTORICAL

Based on an archeological survey of the proposed dam and reservoir basin area, the project will not impact on any archeological or historical sites. No significant antiquities in the watershed will be endangered. The watershed does not contain any places listed on the National Register of Historic Places.

GENERAL

Improved community conditions resulting from this project are expected to expand and strengthen overall rural area development. It will encourage families to remain in the community rather than migrate to more populous urban centers.

One-time capital outlay of construction funds in the form of wages will create an estimated nine man-years of new employment during the construction period. Additional new employment equivalent to 14 man-years will be created within the local economy in the zone of secondary influence of the project.

The watershed project is also expected to have local secondary benefits as a result of increased economic activity stemming from flood prevention benefits. In addition, there will be some increased economic activity induced by operation and maintenance activities of the project.

Additional effects of the watershed project will include some enhancement of property values around the lake resulting from more intensive property development. Cost savings will accrue to the Montana Highway Department for the anticipated replacement of the Baker Lake concrete spillway.

Indirect damages resulting from flooding, including traffic detours and travel delays of residents and travelers, interruptions of utility and communication services, and disruption of normal community activities, will be reduced.

PROJECT BENEFITS

PRIMARY BENEFITS

Total average annual floodwater and sediment damage prevention benefits are estimated at $20,510. See Table 5.

Direct floodwater damage reduction benefits are estimated at $6,240 and include residential benefits of $1,880, commercial benefits of $3,120, and $1,240 of benefits to streets, highways, and bridges.

Total average annual sediment damage reduction benefits are estimated at $13,030. Benefits to Baker Lake and adjoining property are estimated at $7,270 and include $2,960 for preventing further recreation losses in Baker Lake and $4,310 for preventing property depreciation. Overbank sediment deposition benefits are estimated at $5,760 and include $2,940 for preventing additional city operation and maintenance and $2,820 for preventing property depreciation along the channel.

Benefits will accrue from land treatment measures in the form of less water runoff and lower rates of sediment production. Of the total damage reduction benefits, $270 are estimated to be attributable to land treatment measures.

Average annual cost savings and land enhancement benefits which will accrue as a result of the project are estimated at $1,000. See Table 6.

SECONDARY BENEFITS

Local secondary benefits are evaluated at 10 percent of the direct primary benefits that are a result of the watershed project, plus 10 percent of the increases in annual O & M costs. Secondary benefits are estimated at $2,220. See Table 6. Secondary benefits from a national viewpoint are not considered pertinent to this economic evaluation.

UNEVALUATED BENEFITS

Other benefits will accrue to the community in the form of improved environmental conditions, enhancement of pending reclamation of Baker Lake and associated recreational development, and increased interest in all aspects of soil and water conservation. Some depreciation of all property in Baker would result if the watershed project were not installed. This depreciation is considered, but unevaluated. Benefits from sediment entrapment and improved water quality, which will extend outside the watershed, are also unevaluated. Land treatment measures which are expected to reduce floodwater and sediment damages are also expected to lengthen the life of the reservoir.

COMPARISON OF BENEFITS AND COSTS

Total average annual benefits from structural measures are estimated at $23,460. Total average annual costs of these structural measures are estimated at $16,520.

The ratio of total average annual benefits to total average annual costs is estimated at 1.4 to 1.0. The ratio of benefits to costs without the inclusion of $2,220 local secondary benefits is 1.3 to 1.0. Benefits and costs for structural measures are itemized in Tables 4, 5, and 6.

P R O J E C T   I N S T A L L A T I O N

Structural and land treatment measures will be installed during a 5-year period following project authorization. Needed land treatment measures will be installed during the 5-year period to ensure optimum grass and crop use to hold erosion, runoff, and sediment production to a minimum. The installation of structural measures will be carried out during the first four years of the project period. Engineering services and land rights will begin in the first year. Construction of the floodwater retarding structure will begin in the second year. Construction activities, including seeding and associated restorative work, will be completed by the fourth year.

I N S T A L L A T I O N   R E S P O N S I B I L I T I E S

LAND TREATMENT MEASURES

Land treatment measures will be installed on private lands by individual landowners and operators. Technical assistance will be provided by the Little Beaver Conservation District.

The responsibilities of the District will include:

1. Obtaining agreements from owners of not less than 50 percent of the land above the floodwater retarding reservoir to carry out conservation measures and proper farm and ranch plans on their lands prior to the beginning of construction.

2. Providing leadership in the education program that will result in proper application of land treatment measures essential to the success of this project.

3. Encourage the development and use of conservation plans on all lands in the watershed to create a showplace of soil and water conservation.

STRUCTURAL MEASURES

The installation of all structural measures will be the responsibility of the City of Baker. The City of Baker will be the Sponsor responsible for dealing with the SCS during construction. Federal assistance for installing the structural works of improvement as described in this plan will be provided under the authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83d Congress, 68 Stat. 666), as amended. Under this authority the Soil Conservation Service will provide: (1) engineering services including

surveys, site investigations, design, and preparation of plans and specifications; and (2) project administration, including review of engineering plans prepared by others, government representatives, construction surveys, necessary inspection services during construction, and administration of construction contracts as requested by the local sponsors. The City of Baker will furnish local representatives to review plans and construction as necessary to assure local interests are met.

The Sponsoring Local Organization shall meet the following conditions for each portion of construction before issuance of invitations to bid on that unit of construction:

1. Land rights, including flood easements, will be assured by the City of Baker. The Sponsors have sufficient legal authority to acquire the needed land rights and agree to use such authority if necessary. Provision for land rights items relating to various oil and gas companies will be arranged by negotiations between the City of Baker and the respective companies.

2. Mutual agreement shall be reached on the schedule for construction and on plans and specifications. Terms of contracts and all matters pertaining to such contracts shall be mutually satisfactory and in accord with administrative and technical requirements governing the local sponsors and the Soil Conservation Service.

3. Full conformance with local, state, and federal laws shall be the responsibility of the local sponsors. Reasonable evidence of such conformity shall be provided to the mutual satisfaction of all parties at no expenditure of Public Law 566 funds.

METHODS OF INSTALLATION

The contract for the construction of the floodwater retarding structure will be let on a competitive bid basis.

FINANCING PROJECT INSTALLATION

Project costs to be shared by Public Law 566 funds will be paid out of funds appropriated under the authority of Public Law 566, 83d Congress, 68 Stat. 666, as amended. This work plan does not constitute a financial document for obligation of either federal or other funds, including those of local sponsors. Financial or other assistance to be furnished by the Service in carrying out the plan is contingent on the appropiration of funds for this purpose.

The City of Baker and Fallon County are legally constituted organizations under Montana law. Both have the power to borrow money for financing the installation of this project, the power of eminent domain, and the power to levy taxes for repayment of borrowed funds and payment of operating expenses.

LAND TREATMENT

The cost of applying land treatment on private land will be borne by individual landowners or operators in conjunction with assistance as may be provided under going agricultural programs. Technical assistance for land treatment will be provided by the Little Beaver Conservation District in cooperation with the Soil Conservation Service from going program funds at the rate now being provided.

STRUCTURAL MEASURES

Installation costs other than those allocated to Public Law 566 funds will be the responsibility of the City of Baker.

Total local project costs are estimated at $37,030. However, through land trades and negotiations for easements and rights-of-way, local out-of-pocket costs are estimated at $24,000. The City of Baker plans to finance its costs by local mill levies. Most of the local out-of-pocket costs will be for raising a Shell Oil Company oil well for which the company is agreeable to payments over a three-year period.

PROVISION FOR OPERATION MAINTENANCE AND REPLACEMENT

LAND TREATMENT

Land treatment measures will be operated and maintained on private land by individual owners and operators in cooperation with the Little Beaver Conservation District.

STRUCTURAL MEASURES

The operation and maintenance of the floodwater retarding structure shall be the responsibility of the City of Baker in compliance with operation agreements satisfactory to the local sponsors, Montana Dakota Utilities, Butte Pipe Line Company, Shell Oil Company, and the Soil Conservation Service. An operation and maintenance agreement will be executed prior to signing of a Land Rights or Project Agreement, in accordance with the Montana Watersheds Operation and Maintenance Handbook.

The operation of the floodwater retarding structure shall include, but not be limited to, the following:

1. Operating the floodwater retarding structure in a manner that will provide maximum practical sediment deposition. Incidental recreational use such as motor boating that will agitate the sediment and settling process shall be prohibited.

2. Operating the riser gate so the water will be below the elevation of the pipelines (2,939 feet msl) during the period of October 1 to April 1. See Figure 1.

3. Operating the riser gate so it will be closed during storm runoff periods to gain as much sediment entrapment as possible. When the storm has passed and sediment has settled, operate the riser gate to release the water which has been stored in the sediment pool to maintain desired Baker Lake levels.

4. Operating the riser gate and orifice barrel gate to provide emergency withdrawal of waters from the reservoir area upon request from the pipeline companies.

5. Operating the orifice barrel gate so that it is closed down to permanent blocks (partially open) at all times except during a period of pipeline emergency in the

reservoir basin when the gate may be opened to permit rapid evacuation of stored waters.

The maintenance of the floodwater retarding structure shall include, but not be limited to:

1. Keeping all gates, inlets, and openings on the principal spillway works clear of debris and in serviceable condition and repair as needed during the life of the project.

2. Maintain protective vegetative cover and riprap where needed.

3. Keep the inlet and exit channels for the principal spillway free of debris, brush, and other restrictions.

4. Keep the emergency spillway free and clear of any restrictions at all times.

Operation and maintenance costs include items normally expected for repairs and upkeep on the floodwater retarding structure. Total annual operation and maintenance costs are estimated at $750.

A Service employee, responsible for operation and maintenance inspections and followup, and the local sponsors will make a joint inspection annually, after severe storms, and after the occurrence of any other unusual conditions that might adversely affect the structural measures. These inspections will continue annually for three years following installation of each structure. Inspections after the third year will be made annually by the local sponsors and a written report of conditions and recommended actions will be submitted to the Service employee responsible for seeing that operation and maintenance are carried out. In situations where the sponsors have shown lack of ability to carry out inspections properly, or there is an indication of need for continued Service assistance, the Service may continue to provide assistance after the third year at the discretion of the State Conservationist.

The Service employee responsible for operation and maintenance inspections and followup will thoroughly review the sponsors' inspection, operation, and maintenance reports. Evidence that inspections or needed maintenance are not being performed properly and promptly will be reported to the State Conservationist, who must then take appropriate action on reported deficiencies.

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST

Baker Lake Watershed, Montana

Installation Cost Item	Unit	Fed. Land	Non-Fed. Land	Total	Estimated Cost (Dollars) [1/] Non-Federal Lands PL-566 Funds	Other Funds	Total
LAND TREATMENT							
Soil Conservation Service							
Cropland	Ac.		440 [2/]	440 [2/]		1,780	1,780
Rangeland	Ac.		2,560 [2/]	2,560 [2/]		6,480	6,480
Technical Assistance						3,080	3,080
SCS Subtotal						11,340	11,340
STRUCTURAL MEASURES							
Construction							
Soil Conservation Service							
Floodwater Retarding Structure	No.		1	1	191,500		191,500
Subtotal Construction					191,500		191,500
Engineering Services							
Soil Conservation Service							
Floodwater Retarding Structure					22,980		22,980
Subtotal Engineering Services					22,980		22,980
Relocation Payments							
Soil Conservation Service							
Floodwater Retarding Structure					---	---	---
Subtotal Relocation Payments					---	---	---
Project Administration							
Soil Conservation Service							
Construction Inspection					19,150		19,150
Other - Overhead					11,490		11,490
Contract Administration					3,230	600	3,830
Relocation Advisory Assistance Services					---	---	---
Subtotal Project Administration					33,870	600	34,470
Other Costs							
Land Rights						36,430	36,430
Subtotal Other Costs						36,430	36,430
TOTAL STRUCTURAL MEASURES					248,350	37,030	285,380
TOTAL PROJECT					248,350	48,370	296,720
SUMMARY							
Subtotal SCS					248,350	48,370	296,720
TOTAL PROJECT					248,350	48,370	296,720

August 1972

1/ Price Base 1972

2/ Includes Continuing Practices.

TABLE 1A - STATUS OF WATERSHED WORKS OF IMPROVEMENT

Baker Lake Watershed, Montana

Measures	Unit	Applied To Date	Total Cost Dollars 1/
LAND TREATMENT			
Rangeland			
Conservation Plan 2/	Nos.	.1	52
GPCP Contract 2/	Nos.	.1	79
Proper Grazing Use	Acres	130	5
Holding Ponds (oil well wastes)	Nos.	3.0	3,236
Dry Cropland			
Stripcropping	Acres	118	372
Pasture and Hayland Planting	Acres	216	1,404
TOTAL	XXXXX	XXXXX	5,148
			Rounded 5,150

August 1972

1/ Price Base 1972

2/ Portions of 1 Ranch.

TABLE 2 - ESTIMATED STRUCTURAL COST DISTRIBUTION

Baker Lake Watershed, Montana

(Dollars) 1/

	INSTALLATION COST: PL-566 FUNDS					INSTALLATION COST: OTHER FUNDS					
	Construction	Engineering	Relocation Payments	Land Rights	Total PL-566	Construction	Engineering	Relocation Payments	Land Rights	Total Other	Total
Floodwater Retarding Structure	191,500	22,980	---	---	214,480	---	---	---	36,430 2/	36,430	250,910
Project Administration					33,870					600	34,470
GRAND TOTAL	191,500	22,980	---	---	248,350	---	---	---	36,430	37,030	285,380

August 1972

1/ Price Base 1972

2/ Includes $9,250 for lands needed for dam, spillways, and sediment pool; $650 for legal fees, surveys, etc; $1,030 for flood pool easement; $23,000 to raise oil well; $500 to replace gas line; $1,500 to raise service road; and $500 for oil pipeline valves.

TABLE 3 - STRUCTURAL DATA

STRUCTURES WITH PLANNED STORAGE CAPACITY

Baker Lake Watershed, Montana

ITEM	UNIT	TOTAL
Class of Structure		C
Drainage Area Controlled	Sq. Mi.	4.69
Curve No. (1-day) (AMC II)		84
Tc	Hrs.	2.60
Elevation Top of Dam	Ft.	2,955
Elevation Crest Emergency Spillway	Ft.	2,951
Elevation Crest High Stage Inlet	Ft.	2,947.6
Maximum Height of Dam	Ft.	22
Volume of Fill (Including Foundation Backfill)	Cu. Yd.	103,500
Total Capacity	Ac. Ft.	1,460
Sediment Submerged 1st 50 years	Ac. Ft.	408
Sediment Submerged 2nd 50 years	Ac. Ft.	408
Sediment Aerated	Ac. Ft.	0
Retarding	Ac. Ft.	644
Surface Area		
Sediment Pool	Acres	156
Retarding Pool	Acres	238
Principal Spillway		
Runoff Volume (10 day)	In.	3.1
Capacity (Max., Barrel Orifice Controls)	cfs	36
Frequency Operation-Emergency Spillway	% chance	1
Size of Conduit Barrel/Orifice	Dia., In.	48/18
Emergency Spillway		
Rainfall Volume (ESH) (areal)	In.	7.1
Runoff Volume (ESH)	In.	5.24
Type		Earth
Bottom Width (Combined)	Ft.	550
Velocity of Flow (Ve)	Ft./Sec.	4.80
Slope of Exit Channel	Ft./Ft.	0.038
Maximum Water Surface Elevation	Ft.	2,952.43
Freeboard		
Rainfall Volume (FH) (areal)	In.	18.6
Runoff Volume (FH)	In.	16.5
Maximum Water Surface Elevation	Ft.	2,954.96
Capacity Equivalents		
Sediment Volume	In.	3.26
Retarding Volume	In.	2.57

August 1972

TABLE 4 - ANNUAL COST

Baker Lake Watershed, Montana

(Dollars) 1/

Evaluation Unit	Amortization of Installation Cost 2/	Operation and Maintenance Cost	Total
Floodwater Retarding Structure	13,860	750	14,610
Project Administration	1,910	---	1,910
GRAND TOTAL	15,770	750	16,520

August 1972

1/ Price Base 1972

2/ 100 years, 5-1/2 percent

TABLE 5 - ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE

REDUCTION BENEFITS

Baker Lake Watershed, Montana

(Dollars) 1/

Item	Estimated Average Annual Damage Without Project	Estimated Average Annual Damage With Project	Damage Reduction Benefit
Floodwater			
Non-Agricultural			
Residential	2,200	320	1,880
Commercial	3,660	540	3,120
Streets, Highways and Bridges	1,460	220	1,240
Subtotal	7,320	1,080	6,240
Sediment			
Baker Lake and Adjoining Property	7,470	200	7,270
Overbank Deposition	5,950	190	5,760
Subtotal	13,420	390	13,030
Indirect	1,460	220	1,240
Total	22,200	1,690	20,510

August 1972

1/ Price Base 1972

TABLE 6 - COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES

Baker Lake Watershed, Montana

(Dollars)

	AVERAGE ANNUAL BENEFITS 1/					
	Damage Reduction	Cost Savings and Enhancement	Secondary	Total	Average 2/ Annual Cost	Benefit:Cost Ratio
Floodwater Retarding Structure	20,240	1,000	2,220	23,460	14,610	1.6 to 1.0
Project Administration					1,910	
GRAND TOTAL	20,240 3/	1,000	2,220	23,460	16,520	1.4 to 1.0

August 1972

1/ Price Base 1972

2/ From Table 4

3/ In addition, it is estimated that land treatment measures will provide floodwater and sediment damage reduction benefits of $270 annually.

INVESTIGATION AND ANALYSES SECTION

BAKER LAKE WATERSHED WORK PLAN

Fallon County, Montana

August 1972

HYDROLOGY I & A

Basic procedures used in hydrologic investigations are outlined and described in the National Engineering Handbook, Section 4, Hydrology, and comply with the requirements of Engineering Memoranda.

Hydrologic studies were primarily concerned with: (1) determining flood levels in Baker Lake and the channel through the city for various frequency storms; (2) determining the effect of a floodwater retarding structure above Baker Lake on the flood levels; (3) computing and routing the design hydrographs to determine the required size of the floodwater retarding structure and its spillways; and (4) computing emergency drawdown time for various spillway configurations for special considerations.

Basic Data Available

Climatological Data

Precipitation data from the U. S. Weather Bureau station at Baker, Montana, is available from 1925 to present. No temperature data was recorded at this station. However, there are enough climatological stations in the surrounding area to get estimates of temperatures at Baker. The largest amount of rainfall recorded was a total of four inches in 24 hours during June 1955.

There are no gaging stations in the Baker Lake drainage itself; however, there are seven crest-stage gages in the surrounding area with seven years of records. These data are published by the U. S. Geological Survey in "Annual Peak Discharges for Small Drainage Areas in Montana." Seven U. S. Geological Survey water-stage recorder stations selected in the eastern part of Montana provide records of peak flows and annual runoff for periods of 9 to 57 years for use in a regional study.

Soil and Cover Data

Soil surveys have been made in the watershed area by SCS soil scientists. Range and cover condition determinations were made by SCS personnel.

Local Flood Data

There has been flooding of significant magnitude in June 1955. The only flood data available are some approximate lake levels, stages at a motel on the channel below, and the rainfall measured by the Weather Bureau gage at Baker. Data on a recent flood in June 1971 were collected. The data included water level elevations at various points in the channel, depth of flow over the Baker Lake concrete weir outlet, lake level elevations, and rainfall amount and intensity.

Investigations

Peak Flow and Yield Frequency Studies

An annual peak flow-frequency relationship, using the Log Pearson III method was developed for seven crest-stage recording stations on drainage areas from 0.17 to 669 square miles. Both annual peak flow-frequency and annual water yield frequency relationships were computed for seven water-stage recording stations having drainage areas from 233 to 13,194 square miles. Peak flow relationships were developed to check results obtained from the synthetic peaks developed by the Hydrology TR #20 computer program used to model the watershed. A plot of the drainage area versus CSM rates from the results of the frequency analysis showed that the synthetic values were reasonable.

Annual water yield frequency analyses were used to determine the volume of runoff that would be expected to be accumulated in the reservoir from the watershed and possibly held to allow settling of sediment. Average annual water yield is about 150 to 200 acre-feet per square mile (0.6 to 0.8 inches).

Drainage Areas, Times of Concentration, and Runoff Curve Numbers

Drainage areas for the structure site and incremental areas below the site for Baker Lake itself and for various street crossings were planimetered from 8" photographs. The areas were delineated with the aid of a stereo viewer and a Kelsh map made for a portion of the watershed.

Times of concentration were estimated using a velocity of two feet per second for rural areas and 2.5 feet per second for urban areas for the total flow length.

Runoff curve numbers for the various areas were determined using weighted averages of the various soil-cover complexes. Future conditions are estimated to remain the same. The rangeland has lacked proper management in years past, but even with good management, cover condition would not improve sufficiently to reduce runoff since much of the area is a shale soil not capable of supporting cover. The population of Baker is expected to increase very little over the project period. Runoff curve numbers varied from 82 for rural areas to 89 for urban areas. An antecendent moisture condition II was assumed for all runoff determinations.

Synthetic Flood Peaks and Routing

Water surface profiles were computed for sections starting from Baker Lake through the lake outlet channel to the concrete weir

spillway and from below the spillway following the channel through the city of Baker to the junction of the Baker Lake drainage with Sandstone Creek below Baker. The computations were made using the FW-HD1-1130F WSP program.

The watershed was modeled using the Hydrology TR #20 program. Data for the proposed dam, Baker Lake, the channel, and the local drainage areas below the dam and lake were developed and prepared as input into the Hydrology TR #20 program. Runs were made for the 100-, 25-, 10-, and the 2-year 24-hour storms.

The results from TR #20 were as follows:

1. CSM rates were reasonable.

2. Flood levels obtained by the synthetic routing agreed well with levels observed during the 1955 and 1971 storms.

3. Baker Lake levels agree closely with observed levels after the water surface profiles for the lake outlet channel above the concrete spillway were modified to show more restriction due to brush and debris.

4. The proposed dam significantly reduced peak Baker Lake flood levels and resulting lake discharges. Local uncontrolled runoff could still create flooding along the channel and in the park area, but damages to property would be prevented with the project. Larger culverts or a bridge at the 4th Street crossing placed during future city maintenance would help reduce park flooding in this area.

The June 1955 storm was estimated to have a two percent chance of occurrence; the June 1971 storm was estimated to be an event having a 10 percent chance of occurrence.

Structural Design Hydrographs

The design hydrographs for the floodwater retarding structure were developed using procedures in Chapter 21, Sec. 4, of the National Engineering Handbook and routed using methods outlined in Chapter 17. Criteria set forth in Engineering Memorandum 27 were followed. The structure was classified with concurrence of the State Conservation Engineer as class "c". It is on a drainage area of 4.69 square miles, having a time of concentration estimated at 2.6 hours. Both a present and future runoff curve number of 84 was used with an average antecedent moisture condition.

The principal spillway crest was placed at the 100-year sediment pool elevation to achieve better sediment entrapment properties. All hydrograph routings were started at that elevation.

Principal spillway releases are controlled with an 18-inch diameter orifice, or equivalent, at the barrel entrance. An emergency spillway with a 200-foot level crest length was selected to provide bulk against breaching during the passage of the freeboard hydrograph. The maximum head on the emergency spillway was limited to four feet, giving an exist velocity of 8.86 feet per second. An exit velocity versus duration curve was developed for the geologist's and engineer's evaluation. All design hydrograph routings were performed with a reservoir routing program run on the SCS State Office computer terminal.

Special Considerations

The proposed reservoir is going to inundate a significant portion of three pipelines during storm periods, during periods that water is being held in the sediment entrapment, or during periods when excess runoff is held in the sediment pool for later release to maintain the existing Baker Lake at maximum levels for recreation. The pipeline companies requested a 48-hour drawdown capability be incorporated into the proposed outlet works. Stage-discharge curves and drawdown times for several barrel sizes were computed to determine the size drawdown tube required.

A low-stage ungated orifice on the side of the riser at the 50-year sediment level was added to ensure a lower probable water level from which a 48-hour drawdown could be accomplished. Various storm frequency hydrographs were routed to show the peak levels they would reach assuming various initial water levels in the dam. Drawdown times for normal and emergency conditions were computed from these peaks. The results of these computations were tabulated and presented to the pipeline companies for their consideration. Based on this information, they decided that a 48-hour emergency drawdown time computed from the middle elevation of the low-stage orifice would be satisfactory. A 48" diameter principal spillway barrel was determined to have the required capacity to achieve this 48-hour drawdown time. The riser gate and orifice barrel gate (See Figure 1.) can be opened to allow unrestricted flow of the barrel in an emergency. Orifice control with the barrel gate under normal conditions will be achieved by providing blocks to prevent the gate from being completely closed. The barrel was lowered as much as possible to increase the hydraulic efficiency; however, the outlet invert was held slightly above the normal recreation level of Baker Lake to allow for a dry barrel for inspection purposes.

The initial design hydrograph routings were not changed to reflect the low-stage orifice discharge because it is planned to be gated during the last half of the project period.

G E O L O G Y

METHODS AND SCOPE OF INVESTIGATIONS

A preliminary geologic investigation was conducted at potential dam sites. In addition, available geologic maps and reports were reviewed. The geologic conditions were determined to be similar for each of the potential dam sites.

Specific geologic investigations of the selected dam site included detailed surface examination of the watershed area and subsurface investigation with a B-40 mobile drill. Subsurface investigations included borings along the centerlines of the dam, emergency spillway, and principal spillway. In addition, 20 shallow borings were used to outline potential borrow sources. Drilling did not include undisturbed sampling. Each geologic member along the proposed dam centerline was identified and described. Foundation conditions with poor or questionable material were noted and described. Geologic conditions that will influence design were noted. A report of these findings was compiled which included centerline profile of the dam along with geologic cross-sections and description of the proposed borrow areas.

The proposed site consists of saturated, clayey, alluvial fill underlain at shallow depths by sediments of the Cretaceous aged Pierre Shale formation. The abutments are composed of consolidated residual clays underlain by soft shale. The foundation of the embankment will be excavated to shale bedrock. The principal spillway can be founded on bedrock and have an unyielding foundation.

The emergency spillway can be located in either abutment. The spillway bottoms will be in moderately hard shale which will be adequate for the planned frequency of use, estimated at once in 100 years. Some weathering and rilling will occur in exposed shale cuts. This will not affect the safety of the proposed structure. Obtaining a satisfactory stand of grass in the spillway will be difficult unless special seedbed preparations are made over the highly saline marine shales. Materials to be excavated from the emergency spillway were classified by the Unified Soil Classification System. Soil tests were made for classification purposes where necessary. Material at spillway floor elevation was identified and its resistance to erosion evaluated and described. The planned 200-foot long level control sections will be adequate to prevent breaching during the passing of the freeboard hydrograph. Shale excavated from the spillway could be used, preferably in the downstream section of the dam.

Impervious borrow materials are available adjacent to the site. Because deposits are relatively shallow, borrow areas will be relatively large. Clays can be obtained from borrow areas downstream from

the left abutment and in the upper two feet of emergency spillway excavation. These clays are predominantly CH soils. The borrow area locations around the dam site were located and mapped. Borrow materials were classified according to the Unified Soil Classification System. Workable depths and water table elevations were also mapped.

These geologic investigations indicate the site will be suitable for the planned structural development.

SEDIMENT INVESTIGATIONS

Field surveys of sediment yield were made in accordance with prescribed SCS procedures. Field studies included reconnaissance survey of geology and physiography and review of available published pond surveys on Baker Lake and geologic and soil survey publications covering the watershed area.

Sediment pond surveys have been completed on the Baker Lake reservoir. The first was completed by the Soil Conservation Service in June 1937. In July 1955, J. C. Cory, a registered civil engineer, re-surveyed Baker Lake for the City. To supplement the high rate of sediment deposition, an additional reconnaissance pond survey was made in 1970.

Sediment pond surveys of the Baker Lake reservoir indicate very high sediment volumes have been deposited in the lake. The yearly rate of deposition has been relatively uniform since the date of construction even though land use patterns have varied. Original storage capacity of the lake is being depleted by approximately 1.1 percent per year.

Samples of water and sediment were collected from storm inflow into the structure and from various locations in the Baker Lake reservoir. Analyses of these samples were completed by Montana State University and the SCS Soils Testing Laboratory in Portland, Oregon. These tests indicate the sediment is predominantly very fine silts and clays.

Fall velocity analyses, based on data from grain size curves furnished by the soils testing lab, were completed. In addition, suspended sediment samples collected during 1970 and 1971 were observed and settlement times recorded.

Visual observations of these samples indicate that the suspended sediment does flocculate and settle out. Tests with a 1000 ml tube indicated that the major portion of the sediment sample settled out within 12 hours. See Plate 6. Similar tests were made by soils specialists at the Engineering and Watershed Planning Unit of SCS at Portland, Oregon. These observations were similar.

Local observations of water and sediment inflow into Baker Lake were made during 1970 and 1971. These observations indicate that most of the sediment by volume had settled within a week. Wave action tended to keep the very fine sediment in suspension which gave the lake water a light milky color. Observations indicate that this very fine sediment goes into and out of suspension periodically, depending on wave action in the lake. From these observations it was concluded that terminal fall velocity analysis, based on settlement of single grain particle size is not valid to determine settling time. On the basis of these data, it appears that a sediment trap efficiency of at least 90 percent can be achieved in the planned reservoir within a 10-day drawdown period.

E N G I N E E R I N G

INVESTIGATION AND ANALYSIS

Surveys and Investigations

Vertical control for surveys was based upon mean sea level datum. Storage capacities of alternate reservoir sites were determined from a photogrammetric map of the area with contour intervals of two feet, made by the SCS in 1967. Engineering surveys of the dam site, existing spillway of Baker Lake, and the watercourse through Baker were made by SCS field parties. Elevations and locations of roads, wells, and pipelines were obtained from maps furnished by the oil and gas companies, by telephone and written correspondence, and checking sites in the field.

The centerlines of the dam foundation, emergency spillway and principal spillway were investigated by means of auger borings. In addition, borings were used to locate borrow areas. The subsurface investigations show that the conduit will be excavated in shale bedrock. It will be necessary to excavate the foundation for the embankment to bedrock. A cutoff trench excavated into bedrock will control foundation seepage.

Embankment and Riprap

The design and proportions of the embankment were determined by consultation with SCS personnel of the Soil Mechanics Laboratory and Design Section of the West Regional Technical Service Center at Portland, Oregon, and the Soil Mechanics Laboratory, Design Section, and the Watershed Planning Party of Montana. It was determined an embankment with 4 to 1 and 3 to 1 sideslopes would be adequate. See Figure 1. The embankment will have an upstream zone of select material and a downstream zone of shale material. A blanket drain will be placed in the downstream zone just above the maximum water surface elevation of Baker Lake.

A study of locally available rock, gravel, and scoria was made. This indicated that a gravel blanket 2.5 feet thick would provide the necessary stability for wave action on a 4 to 1 embankment slope. The reservoir will be on the leeward side of the dam, and the expected normal low water levels will reduce maintenance requirements to an acceptable level. A blanket of gravel one foot thick will be placed on the remainder of the upstream face and on the top of the dam to prevent desiccation cracking. See Figure 1. Vegetative protection of the upstream face and top of the dam would be an alternative if gravel costs increase. The downstream face of the dam will be covered with topsoil and seeded.

Sediment and Water Analysis

Two samples of Baker Lake water and one of sediment were analyzed by Montana State University. In addition, one water sample and three sediment samples (one each from the upper, middle, and lower part of the lake) were analyzed by the Soil Mechanics Laboratory at the WRTSC at Portland, Oregon. The results of the analysis showed that the sediment will settle quite rapidly, even though the terminal fall velocity of the individual particle size indicated it should stay in suspension indefinitely. It is apparent that flocculation takes place and the sediment soon settles out. Tests made locally to determine rate of settling verified this. See Plate 6. Recommendations made indicated that a riser with the crest at the elevation of the top of the 100-year sediment pool and a small, low level, ungated outlet at the elevation of the 50-year sediment pool would provide an adequate means to achieve a high percentage of sediment deposition. The reservoir would not be lowered by means of the barrel orifice gate except in an emergency. It was also recommended that incidental use of the sediment pool such as motorboating be prohibited.

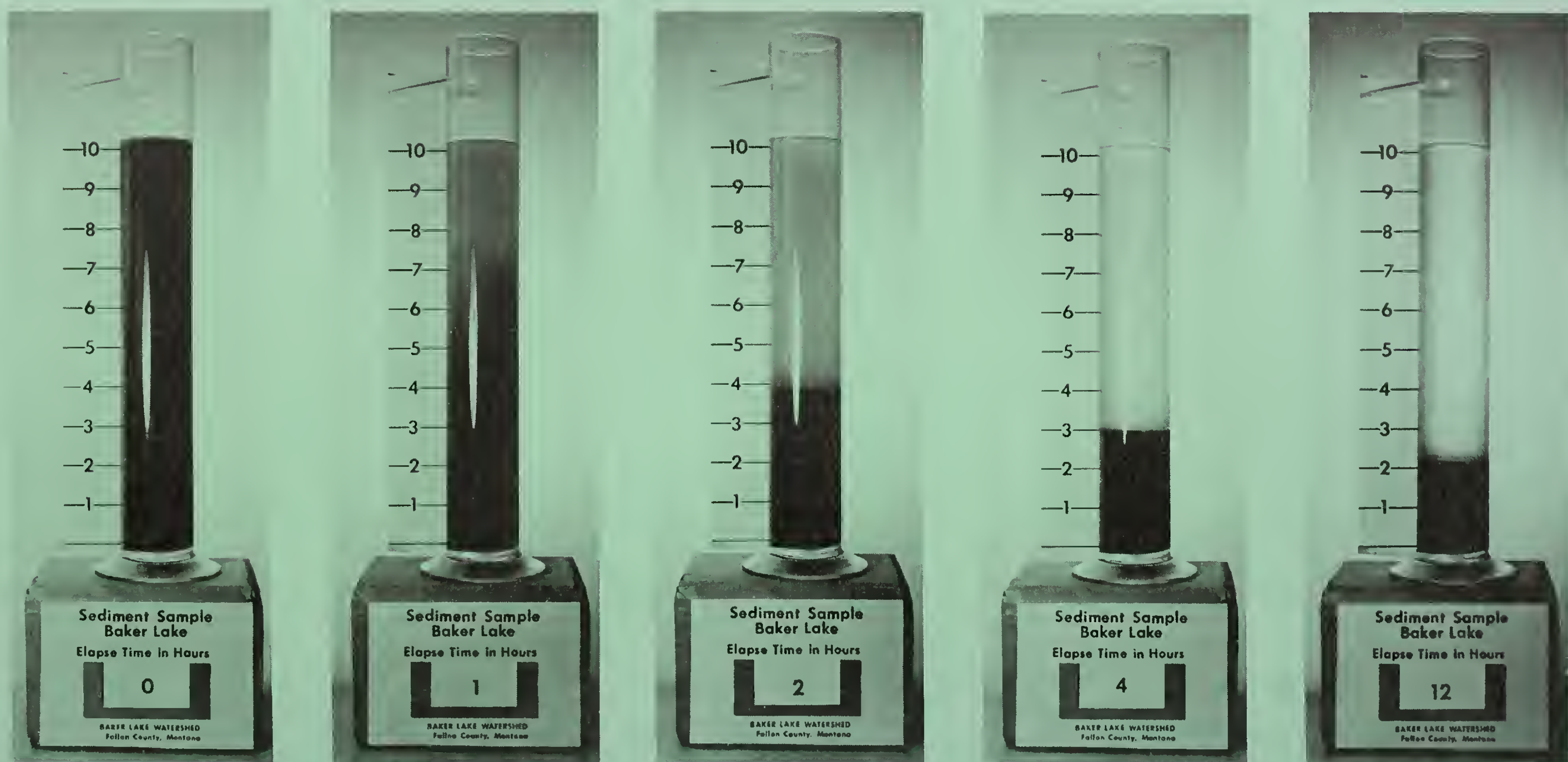
Drainage

Test wells were drilled at pertinent points in town and around the lake. It was determined that there was no correlation between the level of the lake and the groundwater elevation in the test holes.

Costs

Estimates for most construction items were based upon latest prices and dealer quotations. Other costs were updated by the use of current index figures. Contingencies of 15 percent were added for each construction item.

PLATE 6



Visual settling of Baker Lake sediment sample.

E C O N O M I C S

Economic investigation and analysis of the Baker Lake Watershed concentrated on flood prevention. The following section describes the steps and methods of analysis used in determining the economic feasibility of the project.

FLOOD PREVENTION

The newspaper morgue was examined for records of past floods. This secondary source provided very little information except for an article about the June 1955 flood.

Local residents and property owners were interviewed in 1969 and 1970 relative to damages sustained in the 1955 flood. Considerable property development around Baker Lake and along the watercourse through the city has taken place since 1955. Specific reports, records of flood costs, etc., have become somewhat lost with time. However, the interviews yielded sufficient sample information to project the total damages of that flood, at today's prices. This estimate of damage correlated with the damage estimate and report made by the U. S. Army Corps of Engineers in 1968 pertaining to the 1955 flood.

Interviews with local residents, business people, and city officials were conducted following the June 4, 1971 flood. These interviews provided the primary source of flood damage data.

Damage estimates from both the 1955 and 1971 storms were correlated with discharges from Baker Lake and flows along the watercourse through the city. Damage-frequency curves were then developed for both with and without project conditions as a means to estimate average annual floodwater damage reduction benefits. Damage estimates for evaluation storms other than the ones of record were based on synthesized discharge ratios. Gross benefits were adjusted to reflect increased damages in the future due to projected increases in per capita income and personal consumption expenditures. (TSC Note PO-3)

Floodrouting analysis indicated that a significant reduction in the area flooded would be expected with the project. Remaining damages are confined primarily to streets, parks, and low areas immediately adjacent to the channel or areas subject to local urban runoff.

Indirect floodwater damages resulting from such things as traffic detours, disruption of normal community activities, innoculations to prevent disease epidemics, loss of use of parks or ball field, etc., were based on a weighted percentage of direct damage. This percentage was developed from proportions of various types of

damages, i.e., residential, commercial, and highways and bridges, in accordance with Chapter 3 of the Economics Guide and estimated at 20 percent.

SEDIMENT DAMAGES

An intensive study of real estate property values was made for the purpose of determining project benefits that will result from the elimination of the depreciating effects of continued sedimentation in Baker Lake. The market data approach was used to assess the effects of sediment-filled lake on adjoining property. Depreciation was estimated from a comparison between current typical property values around the lake and other properties that have handicaps. These handicaps, which included age, location, and condition, were considered to be similar in extent to the handicaps expected for the lake front property when the lake has filled with sediment. Adjustments were made to reflect a rise in property value prior to the severe depreciation expected 15-25 years hence.

Depreciating effects on property along the channel due to the increased sediment which would be flushed from the lake as the lake filled with sediment were estimated as a percentage depreciation to market value. Future cost savings to the City of Baker for anticipated sediment removal along the watercourse were based on an estimated 15 percent of the sediment from the upper watershed being deposited along the channel within the city.

Recreational use of Baker Lake was projected to expire concurrently with further sedimentation of the lake. Current recreation use figures were supplied by the local City-County Planning Board.

These projected depreciating effects and increased operations and maintenance costs without the project were taken as project benefits.

COST SAVINGS AND ENHANCEMENT

The watershed project will provide cost savings in replacement of the Baker Lake spillway since a smaller spillway could be used. The present structure is old and replacement will likely be needed within or immediately following the period of the watershed project construction. This cost savings benefit, based on an engineering estimate, is attributed to the project.

Minor enhancement benefits are expected to accrue to the borrow area which will be shaped, seeded, and have restorative vegetative plantings. This benefit was estimated on the basis of increased land

value (lower cost) for future development. Other incidental enhancement benefits were estimated for properties around the lake due to more intensive shore and property developments expected after lake stabilization has been assured.

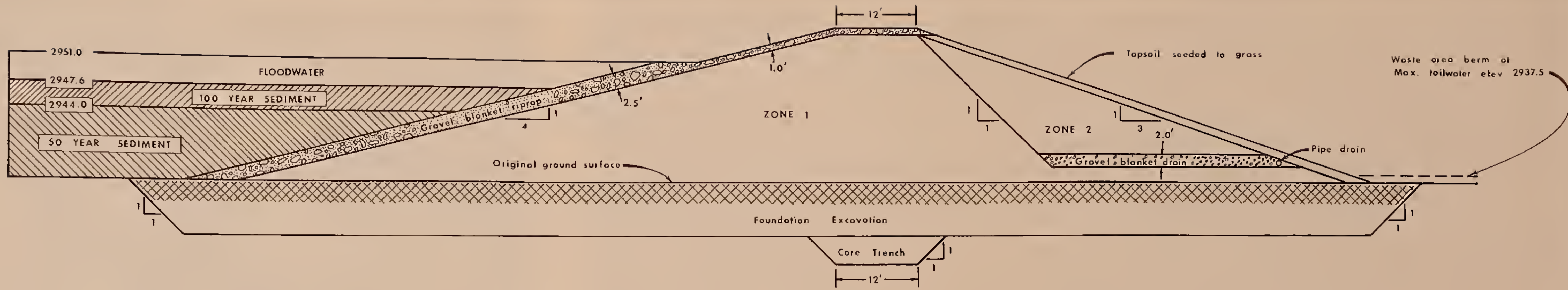
Secondary benefits were computed as a percentage of primary benefits as outlined in Chapter 11 of the Economics Guide. Secondary benefits "stemming from" were estimated at 10 percent of primary benefits and those "induced by" estimated at 10 percent of annual operation and maintenance costs.

Operation and Maintenance Costs

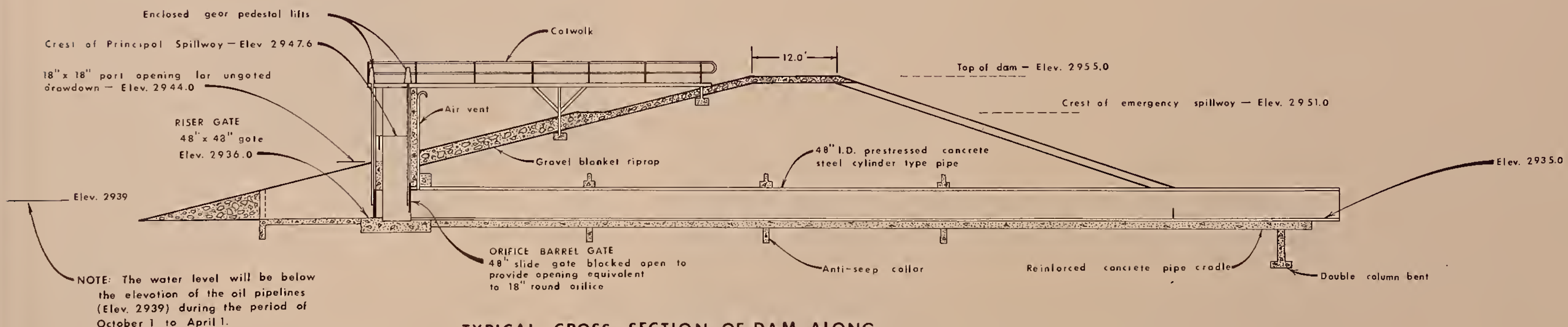
Operation and maintenance costs for structural measures were based on historical data for similar structures.

Amortization of Costs

Costs for structural measures were amortized on the basis of 5-1/2 percent over the 100-year life of the project.



TYPICAL CROSS SECTION OF DAM



TYPICAL CROSS SECTION OF DAM ALONG CENTERLINE OF PRINCIPAL SPILLWAY

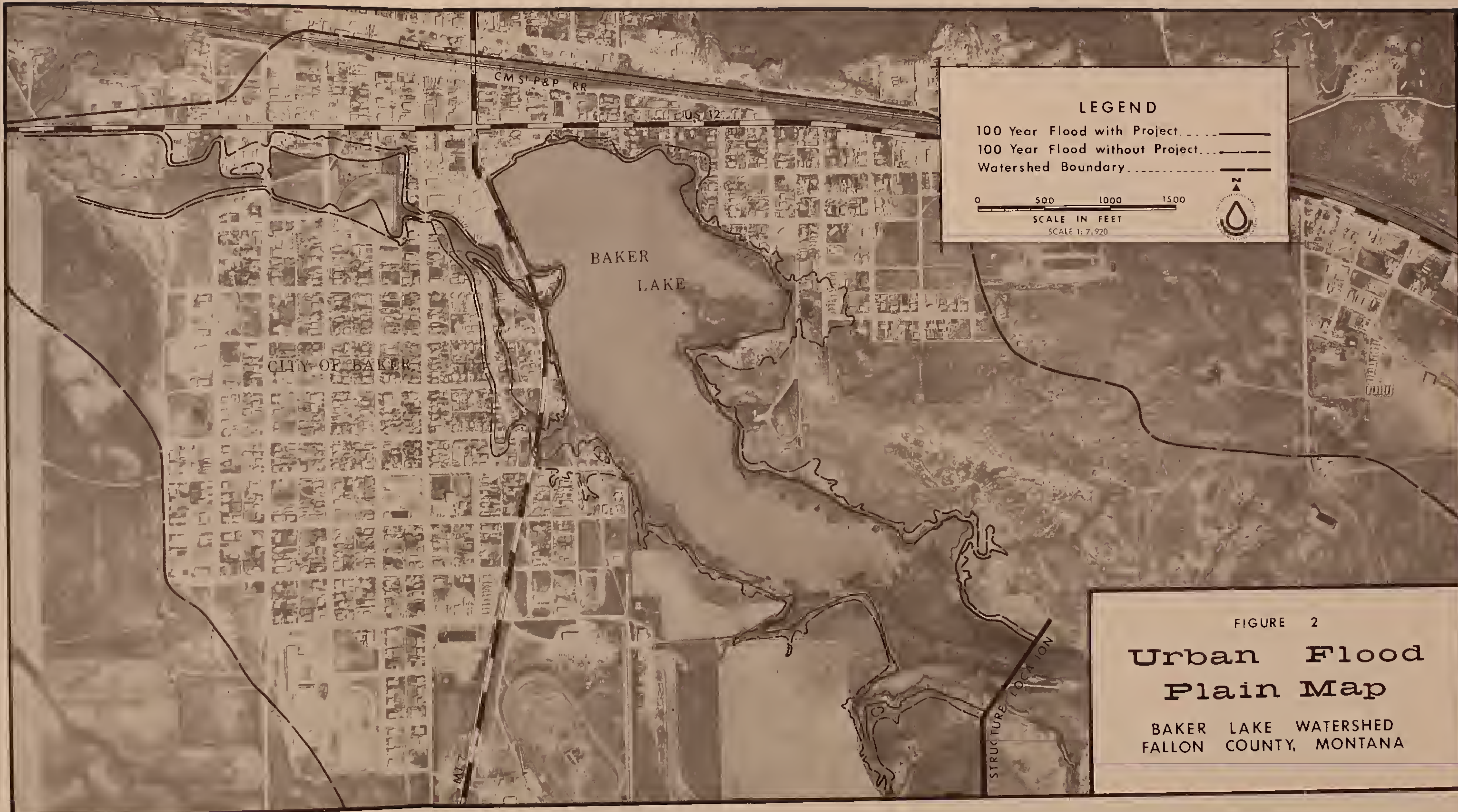
ALL ELEVATIONS BASED ON MEAN SEA LEVEL DATUM

0 10 20 30 40 50 60
SCALE IN FEET

FIGURE 1
CROSS SECTIONS
FLOODWATER RETARDING STRUCTURE

Baker Lake Watershed
FALLON COUNTY, MONTANA

USDA-SCS-Bozeman, Montana-1971



Base from 1967 aerial photography
Prepared by W & RBPP Bozeman Mt

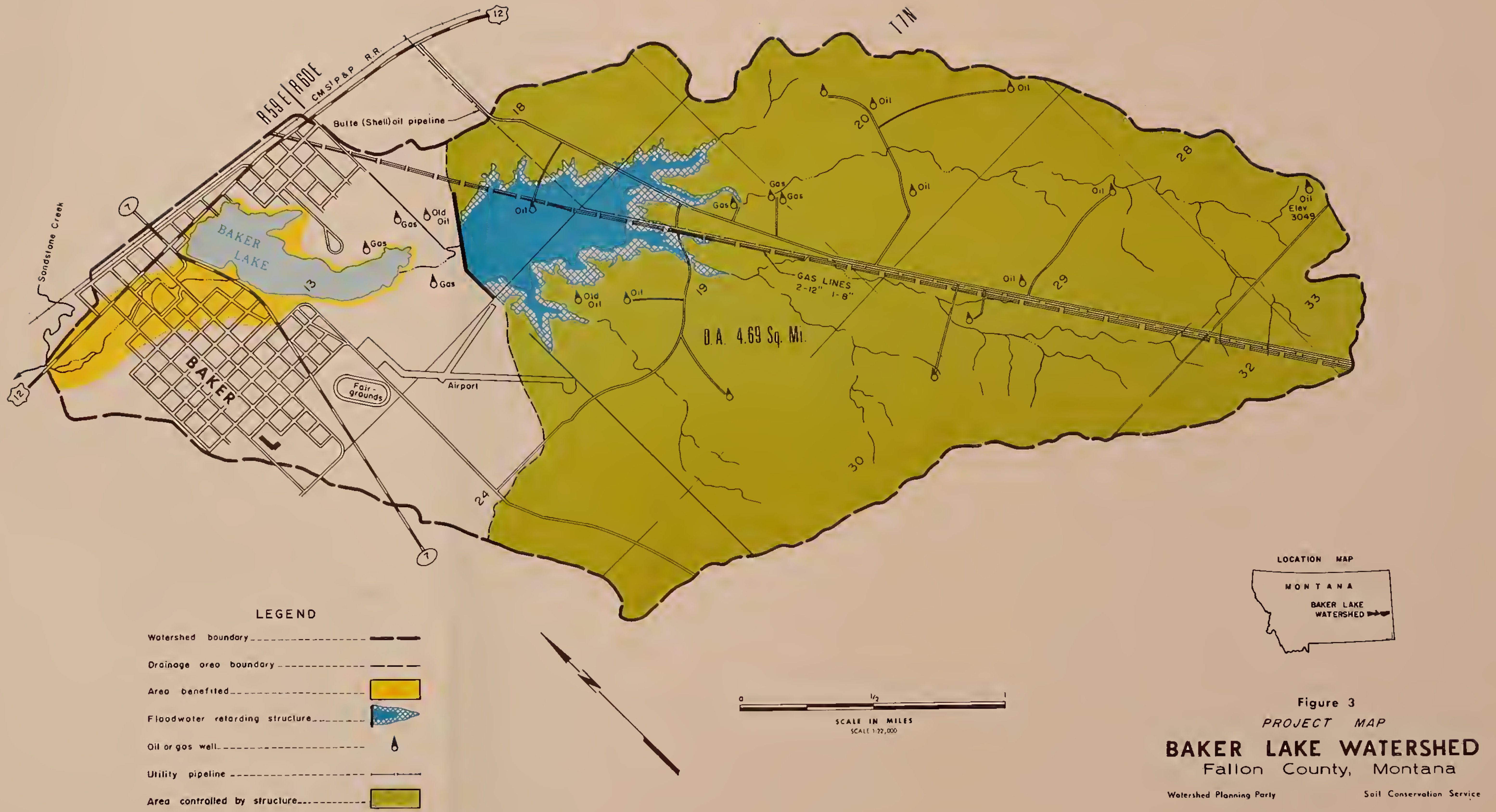


Figure 3

PROJECT MAP

BAKER LAKE WATERSHED

Fallon County, Montana

Watershed Planning Party — Soil Conservation Service